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COVER PHOTO

Reviewing the troops of the Army Chemical Center at the formal parade held at the conclusion of the second day of the AFCA Annual Meeting are: Front row L-R, Lt. Col. Evan H. Bell, Brig. Gen. E. F. Bullene and Col. Harry A. Kuhn. Second row L-R, 1st Lt. Paul P. Morton, Maj. Joseph A. Glover, Capt. William G. MacFarlane, Lt. Col. Carl W. Bartling and Maj. Thomas E. Marfing.

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NEWS OF THE SERVICES

Military Leaves of Absence

Secretary of Defense Louis Johnson is urging all employers of members of Reserve Components of the Armed Forces to be liberal in granting them special leaves of absence to participate in annual periods of military training. In a statement addressed to "The Employers of the United States," Mr. Johnson pointed out the importance to national security of maintaining a large well-trained and enthusiastic military reserve force. "Cooperation of employers, by adopting a liberal policy in granting leaves of absence, is fundamental," Secretary Johnson said, "because the strength, skill and teamwork of our Armed Forces reserves depend upon participation in the annual training activities." Secretary Johnson's appeal to employers was made at the request of Chairman Thomas R. Reid of the Personnel Policy Board of the National Military Establishment.

* * *

Selling to Armed Services

As an "assist" to industry, the three military departments and the Munitions Board have issued publications to aid businessmen seeking military procurement contracts in finding the proper channels of information. The booklets are intended particularly to aid small concerns that have not previously established sales relations with the armed forces. Emphasis is placed on methods of obtaining subcontracts. The Air Force booklet may be obtained by writing the Commanding General, Air Materiel Command, Dayton, Ohio; Navy pamphlet, Government Printing Office, Washington, D. C.; Army booklet, Procurement Information Center, Office of Assistant Secretary of Army, Pentagon, Washington, D. C.

* * *

Civilian Component Board

Since taking over as the nation's Secretary of Defense, Louis Johnson has established a record for eliminating "useless" boards within the military establishment. Nearly 100 boards have been clipped accordingly. However, an indication of his interest in the reserve components, is his first board creation, the Civilian Components Policy Board, established in late May. The board, which will be permanent, is authorized to study and evaluate all questions affecting the organized reserves of Army, Navy and Air. The purpose of creating the Board is to develop and coordinate in the office of the Secretary of Defense, all policies concerning the civilian components. It will also establish policies governing the size, composition, mission and type of units, insofar as the geographical location of those units, in the various communities based upon information furnished by the National Security Resources Board and the Munitions Board as to the availability of manpower for the Civilian Components in those communities. Meanwhile, observers point out that the outlook for Reservists is brighter now than any time in history.

* * *

"Gag" Rule Cancelled

To "avoid further misunderstanding and misinterpretation," Bill Frye, public information director for Defense Secretary Johnson cancelled "Consolidation Directive No. 1" which established a central security review branch in the Office of Defense and was interpreted as laying down strict new rules against disclosures of military information. Since publication of the directive PRD Frye had been trying to convince editors and reservists that the order did not require all military personnel to submit all articles, speeches and public statements to the office for prior censorship. However, the task proved insurmountable and the order was crossed off the books. Now members of the armed forces, regulars and reservists, will be bound by the security review regulations of their particular service. In other words, the original directive was "decentralized" and the "heat" of critics blasts distributed among the three services.

Military Contract Awards

A listing of contracts awarded to private business concerns in amounts of $100,000 and over and announced by the Department of the Army include: Phillips Chemical Co., Bartlesville, Okla., Ammonium Sulphate, 20,000 tons, $592,100; Hercules Powder Co., Wilmington, Del., Reactivation of powder facilities and production of JPN Sheet Rocket Powder, 250,000 tons, $400,000; U. S. Industrial Chemical Inc., New York City, Compound, antifreeze, 105,000 gallons, $194,250.

* * *

Tag's TWX

In a TWX message to all army commanders, the Army Adjutant General advised that in the future the word "Reserve" will be substituted for "Inactive" in references to training pay and training duty for Reserve personnel of the Army. Accordingly, it is now Reserve Duty Training Pay and Reserve Duty Training.

* * *

Active Duty Rank

Date of rank for Army Reserve officers recalled to active duty is computed to exclude any periods of inactive status. An officer recalled to duty ranks from a date preceding that on which he is placed on active duty by a period equal to the total length of active Federal commissioned service performed in that or a higher grade. Thus, a Reserve Army colonel appointed to that grade on 1 January 1945, relieved from active duty on 31 December 1945 and recalled to active duty in the grade of colonel on 1 July 1946 ranks from 1 July 1945. (Army SR 605-80-1.)

* * *

Waiving Retired Pay

The Comptroller General has ruled that retired pay authorized under Title III, Public Law 810 (Reserve Retirement) is not such pay as may be waived for the purpose of receiving compensation or pension from the Veterans Administration.

Annual Meeting

REPORT OF COL. HARRY A. KUHN

President, AFCA

To Directors and Members Armed Forces Chemical Association

It gives me great pleasure to welcome you to this Fourth Annual Meeting of your Association. The Executive Committee and your President are now called upon to render an accounting to you of our stewardship for the past year.

During the past year we have continued to grow, not only in size, but in functions. I feel that we are firmly established, not only among the chemical and industrial fraternities but also in the three armed services.

The main difficulty during the past year has been financial. Our annual dues have been unchanged since we organized but the cost of our publications and operations has risen steadily. At the same time we suffered a loss in advertising, although we reduced our advertising rates to conform with other publications of equal standing. However, the picture is not as gloomy as the balance sheet might indicate. Many of the actions of the Executive Committee were long range and should bear fruit this coming year.

Despite a reduction in income we increased our services to our members. We brought out a directory of our members and issued a supplement bringing it up-to-date as of January. We plan to issue a directory each six months during the coming year and hope to finance it in part by carrying advertising. We have reorganized the Journal and the Newsletter which now have a new editor, new advertising manager and a new printer.

We have established the annual award of AFCA medals to the outstanding student in each of the Chemical Corps ROTC Units and to a like number of ROTC Units in the Navy and Air Force, and in addition we will present a medal to the outstanding student at the summer ROTC Training Camp at the Army Chemical Center.

We have established a plaque to be awarded to our industry members and have adopted a new card and certificate to be presented to life members. We have revised our accounting system and placed our operations on a budget system.

We have removed from general funds the life membership fees which have been invested and currently the interest from the investments is covering our life membership annual dues. We have removed from our general funds and invested \$400 of the \$500 sustaining membership fee as the nucleus for a reserve fund. We have conducted drives for membership through the chapters, through the non-member Chemical Corps Reserve officers and in industry. The returns have been very good but not as we had anticipated.

During the past year we secured three sustaining members, retained almost all our old group members and secured 12 new ones.

The credit for not only keeping practically all our old members on the rolls but for securing over 400 new members this year goes to the excellent work done by the chapters at the Army Chemical Center, Rocky Mountain Arsenal, New York, Los Angeles, Wilmington and the European chapter.

At the last annual meeting we released the Chemical Corps History of World War II which the Association published. The sale of this book has been a disappointment. One of the main objections has been the price. This has been established with the objective of securing a substantial return to the Association.

We have had no changes proposed in either the Constitution or By-Laws this year. It has been recommended that the Executive Committee for the coming year consider increasing the dues for group membership from \$100 to \$150 per year leaving unchanged the 20 member proviso. At present, group membership is no more than the payment by a company of twenty \$5 memberships. The company secures without further charge many advantages and privileges which involve expense to the Association. I believe our group members will not object to paying their way. A number of other means of increasing revenue by voluntary subscriptions have been recommended also for consideration.

During the past year we have suffered the loss of two of our Directors at Large. Mr. George W. Dolan, Chairman of the Board, Mathieson Chemical Corporation, died last July. He was a friend of the Chemical Corps and of the Association of long standing. For many years he was Assistant District Chief of the New York Chemical Warfare Procurement District and I had the privilege of being closely associated with him when I was Commanding Officer of the District.

The Association as well as the whole chemical world was shocked by the death of Dr. Willard H. Dow, President of Dow Chemical Company, in March. The name of Dow has been closely associated with the Chemical Corps since 1918 when a branch of Edgewood Arsenal was established at the Dow Plant at Midland, Mich. Dr. Dow actively supported the formation of this Association and has been a director since its organization. He also supported our publications through advertising. Last year when we established the sustaining membership category, Dow was the first concern to become a sustaining member. His loss will be long felt.

As I pointed out in my initial message last July, this is not a one-man organization. The Association will be just what you help to make it. We cannot stand still. We must continue to grow or go backwards. We need your help to secure additional individual members, and to secure industry group members, to secure sustaining members, and to secure advertising. We are probably one of the very few organizations of any kind that has not raised its dues substantially in the past few years. I hope that we can continue in this select group. We can only do so with your help.

REGISTRATION
AFCA's Annual Meeting was judged . . .

INFORMATION
. . . a "best yet" conclave at Edgewood.

Amid a spirit of unification that may easily set a pattern for the professional services, the Armed Forces Chemical Association at its fourth annual meeting at the Army Chemical Center (May 19-21) combined the talents and interest of Army, Navy and Air Force departments and recorded for historical purposes a "best yet" convention. Indicative of the singleness of purpose on the part of Association officers, committees, industry and membership to stage a successful meeting, AFCA's 1949 convention proved itself an outstanding success.

Association "early birds," refusing to break with precedent, began arriving at Edgewood on May 19, a day set aside for registration of the Board of Directors and those desiring to see the convention through from the opening day. That evening the Board held its annual dinner and meeting naming the following as officers of the Association: Honorary President, Maj. Gen. Alden H. Waitt, Chief Chemical Corps; President, Col. Harry A. Kuhn; 1st Vice President, Dr. Walter E. Lawson; 2nd Vice President (Chairman of Fnance) Richard H. Turk; 3rd Vice President (Chairman of Membership and Organization) Lt. Col. Elliott Morrill, CmlC-Res; 4th Vice President, (Chairman of Publication) Brig. Gen. J. M. Eager; 5th Vice President(Chairman of Meetings and Conventions) Col. Robert T. Norman, CmlC-Res; 6th Vice President (Chairman of Research and Development) Dr. Walter R. Kirner; 7th Vice President (Chairman of War Mobilization Planning) Col. Samuel Cummings, CmlC-Res; Immediate Past President, Col. Ludlow King, CmlC-Res; Secretary-

AFCA's FOURTH ANNUAL MEETING
A REPORT FROM EDGEWOOD

MATERIEL EXHIBIT
Objective: AFCA's '50 and '51 meeting . . .

FIRE BOMB DEMONSTRATION
. . . sponsored by the Navy and Air Force.

Treasurer, Fred M. Jacobs; General Counsel, Maj. Charles E. Pledger, Jr., CmlC-Res.

At the meeting of the Board of Directors, Col. Harry A. Kuhn in reciting a brief resume of the years activities stated that while the association had not expanded to the extent anticipated it had managed to record a constant increase in membership and operational functions. He reported that the Executive Committee had met on an average of once a month with committeemen attending from as far distant as Chicago. Colonel Kuhn acknowledged also the reorganization of AFCA's publications and the employment of a new editor, advertising representative and printing firm.

The Board of Directors were advised of the Association undergoing a financial reorganization, including the establishment of a working budget and the investment of a fixed reserve fund from sustaining and life membership funds which has netted sufficient dividends to pay the dues of life members. In addition, an increase in group and sustaining members was noted during the year, as well as an increase from 2800 to 3200 individual memberships which, it was pointed out, was due in large part to the outstanding efforts of the Army Chemical Center Chapter, Rocky Mountain Chapter, New York Chapter, Los Angeles Chapter, Wilmington Chapter and the European Chapter of AFCA.

There were no changes proposed in either the Constitution or By-Laws of the Association.

Tribute was paid to two Directors-at-Large who died during the year, Mr. George W. Dolan, Chairman of the

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DIRECTORS-AT-LARGE, AFCA

1949 — 1950


DR. WALTER R. KIRNER
National Academy of Science


DR. HAROLD C. WEBER
Massachusetts Institute of Technology


DR. D. B. DILL
Army Chemical Center


HENRY C. FISCHER
Army Chemical Center


L. T. SUTHERLAND
Allied Chemical & Dye Company


WILLIAM J. HARSHAW
Harshaw Chemical Company


DR. H. F. JOHNSTONE
University of Illinois


R. M. MARSHALL
Pittsburgh Coke & Chemical Co.


DR. H. N. WORTHLEY
Research & Development Board


DR. WILLIAM N. LACEY
California Institute of Technology


SIDNEY D. KIRKPATRICK
Chemical Engineering


DR. WALTER J. MURPHY
Industrial Engineering Chemistry


COL. E. R. BAKER
Continental Oil Company


DR. ALBERT W. NOYES
University of Rochester


COL. L. WILSON GREENE
Army Chemical Center


DR. ALSOP H. CORWIN
Johns Hopkins University


DR. P. K. FROLICH
Merck and Company


COL. LUDLOW KING
Owens Corning Fiberglas Co.


DR. DONALD B. KEYES
Heyden Chemical Company


M. G. MILLIKEN
Hercules Powder Co.

AFCA'S FOURTH ANNUAL MEETING

(Continued from Page 4)

Board, Mathieson Chemical Corp. and Dr. Willard H. Dow, President, Dow Chemical Company. The Board acknowledged that their deaths proved a loss not alone to the Association but to the entire chemical industry of the nation.

Dr. Walter E. Lawson submitted a report concerning the activities of the Medals and Awards Program of the Association. He submitted samples of the medals, plaques and scrolls, which met with the approval of the entire Board. Fourteen medals with their accompanying scrolls will be presented this year to outstanding ROTC, NROTC and Air ROTC and Edgewood summer school students. Evidence was at hand that the recognition afforded by AFCA to outstanding military students is meeting with outstanding success and is destined to prove of material benefit to all concerned. Plaques to AFCA group members have generated widespread interest and numerous letters of appreciation from companies have been received by the Association's National Headquarters.

Finances

Lt. Col. Edward Mery, in the absence of 2nd Vice President Richard H. Turk, submitted a financial report rendered by the Certified Public Accountant employed by the Association. The report gave a net worth of the Association as $6,392.27.

Secretary's Report

Mr. Fred M. Jacobs, AFCA's Secretary-Treasurer, submitted a report on membership which is quoted in part as follows:

"Your Association has passed a busy and a fruitful year. Since our last Annual Meeting much has been accomplished. As an organization we have grown in numbers, strength, stability and prestige. This growth has been the consequence of a demonstrated ability to perform service. Established three and a half years ago because of a widespread conviction that such an Association could be of vital service to the cause of our National Chemical Defense, events have thoroughly justified this faith. Some of the missions visualized by our founders have been subordinated by the turn of events, other missions have proved of even greater importance than was foreseen. Today we can report that the practical value of our Association to the cause of National Defense has become recognized by the military establishment, by the Chemical industry and by the great reservoir of military and technical talent that composes our membership.

". . . Our headquarters is a busy place. It handles a multitude of inquiries, requests for information and for specific services springing from many sources. We have set up the machinery for handling such requests and it is functioning well. The internal affairs of the Association, the promotion of its membership and the production of its publications have been established upon an economical and a satisfactory basis. We achieved a position where we are not only geared to handle the many demands which are presently made upon us, but are ready and reaching out for the new and greater demands which we confidently anticipate."

Publications

After a discussion pertaining to increasing the subscription rate of AFCA publications to non-members, it was unanimously agreed to increase the rate to $5 per year for non-members. In accordance with postal regulations this rate may be twice the amount allocated from dues for publications which is $2 for the Journal and 50c for the News.

Colonel Harry Kuhn announced that since the Directory of the Association has been so widely acclaimed it is being made a permanent publication, being produced twice a year in July and January.

Research and Development

Dr. Walter R. Kirner, chairman of AFCA's Research and Development Committee, reporting to the Board of Directors stated in part: "Sixteen of the local chapters of the Association have appointed research and development committees. These committees are standing by and should be given some worthwhile duties so as to keep up their interest. You are undoubtedly familiar with the organization of the Research and Development Training Groups of the Officers Reserve Corps. These groups are working on a larger number of projects. It should be possible for Research and Development Committee of this Association to have suitable projects assigned to it which will utilize the special training and experience of its members."

Referring to the April issue of The Armed Forces Chemical Journal which featured an article, "A Reserve Looks at the Association," Doctor Kirner stated: "In this article it was suggested that certain reserve Chemical Corps officers would be interested in serving their tour of duty in one of the research laboratories of the Army Chemical Center. This same suggestion had previously been made by the members of the research and development committee of the Boston Chapter. This seems to me to be an excellent idea if it can be arranged. The Chemical Corps has been recruiting young scientists from a number of universities for work at Edgewood during the summer. Perhaps these young men could be supplemented by a number of qualified Reserve officers who had worked at Edgewood during the war and who already have a good background of experience on Chemical Corps problems. Their employment during all or part of each summer would keep them up-to-date on current Chemical Corps progress and would utilize their experience and maintain their active interest in the Chemical Corps."

Mobilization and Planning Committee

In the absence of Col. Samuel Cummings, 7th Vice President, his deputy, Mr. Douglas Weiford, reported the services of the Mobilization and Planning Committee have been offered to the Munitions Board and the National Security Resources Board, as well as to industry. He stated that while the President of AFCA is a standing member of the Munitions Board Chemical Advisory Committee and close liaison is maintained with the NSRB, the entire problem requires investigation to establish a pattern for the future action of the committee.

Future Meetings of AFCA

Concerning the subject of future meetings of the Association, Roy D. Kulp, 5th Vice President and Chairman of Meetings, stated in part to the convention: "It is my definite recommendation that annual meetings be held in various parts of the country under the auspices of various units of the Armed Forces. Ours should be a truly representative organization and if all meetings are held at the Army Chemical Center, the fact that we serve all branches of the military establishment may be lost sight of. The Army, Navy and Air Force must be made to realize that our association is designed to further the interests of all concerned. Then, too, our members in other parts of the country, even though outnumbered, should be made to feel that they are not

being overlooked. I am very glad that there is the possibility that next years meeting may be under the sponsorship of the Air Force and I hope that the following year the Navy may sponsor the meeting."

AFCA's Board of Directors went on record favoring the next two annual meetings to be sponsored by the Navy and Air Force with a return to Army Chemical Center in 1952.

Industry-Army Day

Industry-Army Day, sponsored by the Coordinating Committee of Armed Forces Associations, will be held next year in New Orleans at the time of the annual Mardi Gras. The Louisiana Chapter of AFCA will act as the host chapter for the event.

Annual Meeting

The Annual Meeting of the Association was held on Friday, May 20th in the auditorium of the Chemical Corps School. Following the report of Col. Harry A. Kuhn (see page 3) AFCA's President stated that the services of the Research and Development Committee as well as the War Mobilization Planning Committees have been made available to the various agencies concerned with national defense. Also, individual members of the Association have been called as consultants to government agencies concerned with Chemical Corps problems.

Membership attending the meeting heard full reports as received by the Board of Directors from the various committees. Concerning the suggestion that group membership rates be raised to $150 per year, a lengthy discussion resulted in the decision that such action would possibly result in the loss of more companies than could be secured in financial compensation as the consequence of raising dues. This subject, along with other matters submitted by committeemen, will be brought before a future meeting of AFCA's Executive Committee for appropriate determination and action.

Exhibits—Demonstration

At the close of the Annual Meeting, a box lunch was served from a field kitchen on the parade ground. Afterwards, membership and their guests were guided through various tents that were erected on the parade ground to view exhibits of Chemical Corps materiel. Following this presentation, members were guided to the demonstration area where the initial event was the firing of the 4.2 inch mortar to demonstrate the water impact of this type mortar.

Demonstrations of the portable flame thrower, the mechanized flame thrower, the Navy's floating smoke pot, and a demonstration of colored smoke, rifle and hand grenades were also presented.

The "Aerojets" of the 4th Fighting Wing, Langley Feld, Va., closed the demonstration with an exhibition of aerial acrobatics with four of the Air Forces' jet fighter planes.

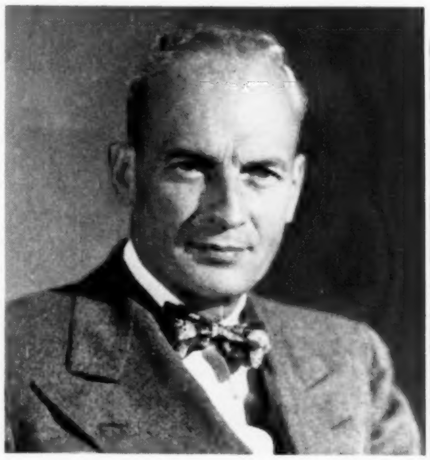
The group moved to the parade ground and witnessed the troop review. Col. Harry A. Kuhn, President of AFCA, reviewed the troops with Brig. Gen. E. F. Bullene, CG of the Chemical Center, and other officers of his staff. The troop commander was Lt. Col. Edgar V. H. Bell, commanding officer, 2nd Chemical Mortar Battalion.

Mixer—Banquet

At 5:30 p.m. a cocktail party was held at the recreation hall after which was held the annual dinner, with appropriate messages from Col. Harry Kuhn and guests of honor. A fireworks display was held outside following the banquet. The evening was rounded out by dancing to a seven-piece orchestra.

AFCA's
ANNUAL MEETING BANQUET

MR. DONALD F. CARPENTER OUTLINES PROGRAM OF THE MUNITIONS BOARD TO ASSURE ADEQUATE PREPARATION FOR A FUTURE EMERGENCY. MAJ. GEN. ALDEN H. WAITT URGES ASSOCIATION TO NURTURE OUR CHEMICAL WEAPONS.



DONALD F. CARPENTER
Chairman, Munitions Board

MAJ. GEN. ALDEN H. WAITT
Chief, Chemical Corps

REAR ADMIRAL JOHN A. SNACKENBERG
USN Bureau of Ordnance

BRIG. GEN. EDWARD MONTGOMERY
USA Logistics Division

A series of glowing tributes were paid the Armed Forces Chemical Association by guests of honor appearing at the banquet concluding the Annual Meeting at Edgewood. Outstanding representatives of the National Military Establishment acknowledged the efforts of AFCA in the field of national defense and emphasized the need for a strong, virile organization coupled with a working desire to sustain the nation's chemical preparedness.

Heading the guests of honor at the banquet was Mr. Donald F. Carpenter, Chairman of the Munitions Board. Mr. Carpenter stated that the accomplishments of the chemical industry need no comment as during World War II the industry performed miracles to accomplish its production assignment. While stating that the industrial strength of the United States has no equal among nations, Mr. Carpenter stressed the point that the importance of acquiring supplies has "grown by leaps and bounds." Looking to the future, Mr. Carpenter stated, "future emergencies may find the circumstances changed. We may not have time unless we are adequately stockpiled." He warned—"Too little, too late must be avoided." Continuing, Mr. Carpenter stated, "We must plan on speed in mobilization with a minimum of impact on peacetime industrial requirements."

In outlining the work of the Munitions Board, Mr. Carpenter stated the program includes the cataloguing of five million items; acquiring a uniformity of specification aimed at standardization; uniformity of procurement for the military services; elimination of the duplication of facilities and services in the military; uniformity in contract procedures and coordination of current buying from industry. "Private enterprise represents one of the major strengths in our system," said Mr. Carpenter and he emphasized the program of the Munitions Board is to support this point.

* * *

Appearing in the capacity as what he termed his "swansong as Chief of the Chemical Corps," Maj. Gen. A. H. Waitt reporting on progress of the Chemical Corps said, "We have had a good year." General Waitt exclaimed that the Chemical Corps has taken on additional responsibilities and accordingly has new assignments. To substantiate his claim, General Waitt reported that from a financial standpoint we have "another year with increased appropriations." He added that politically the Corps is stronger than ever before in history and chemical warfare's responsibility to the national defense has reached an all-history high. General Waitt warned that "chemicals are what we will be concerned with in World War III and the Armed Forces Chemical Association must be sure those weapons are maintained and nurtured."

General Waitt expressed his appreciation for the loyal support of the Association and cautioned AFCA that a "big job lies ahead." He urged that the Association be on guard to watch the present laws and proposed legislation that concerns the future utilization of the Chemical Corps.

Representing Maj. Gen. Richard C. Coupland, Director of Armament,

(Continued on Page 40)

LOGISTICAL SUPPORT OF COMBAT

By

Brig. Gen. Edward Montgomery

WITH THE CHANGE IN THE COMPOSITION OF TROOP UNITS IN THE ARMY, THE REQUIREMENT FOR LOGISTICAL SUPPORT HAS BEEN ALTERED AND THERE IS A NEED FOR A SET FORMULA WHICH EVOLVES A BALANCED ELEMENT OF COMBAT AND LOGISTICAL SUPPORT UNITS WHICH CAN SATISFY BOTH THE COMBAT AND LOGISTICAL MISSION.

The question of how to supply personnel to do all the multitude of jobs in a war affects all of us. When the personnel needed must be technically suitable, it is of special interest to members of such an organization as the Armed Forces Chemical Association. There are two main divisions into which personnel needs may be divided and they conflict. The one—the need for men and women for the military services—and the other—the need for men and women for civilian activities—industry, research and development, sciences and all of the other jobs for which deferment is allowed.

These conflicts between requirements seem always to be resolved somehow or other so that we get the many jobs done. Hence, few people interest themselves in their resolution in time of peace.

Most people do not realize that, within the military requirements, there is an equally important conflict which is possibly more difficult to adjust than the one between the civilian and the military needs. This is the conflict between the two aspects of personnel mobilization requirements which, at least in the World Wars with which I have been involved, are so conflicting as to endanger our early effort. At least they are conflicting as to each other even if not conflicting with respect to the main issue of success in winning the war.

The one is the requirement for personnel to man the fighting units—the combat troops, such as infantry, field artillery and armored units. The other is the requirement for personnel to man the logistical support units.

By logistical support units we mean those military units which do not fight but upon whose successfully accomplished tasks depends the success of the fighting units, without which the fighters could not win. Truck companies, ammunition companies, R.R. transportation battalions and depot companies, to mention a few well known examples, and for the Chemical Corps, such units as decontaminating companies, service units, chemical processing units, chemical depot companies, together with such very technical units as the technical intelligence and laboratory units.

The demands for personnel for these units conflict not only with the needs for combat personnel but, since many of the units are technical to quite an extent, also with civilian demand. This is particularly true of Chemical Corps units in which a failure to secure qualified technicians spells failure to accomplish their mission successfully.

Integration Problem

A very important problem has been, and will continue to be, the integration into the design and make-up of logistical support units of those new developments in weapons, tactics and concepts resulting from World War II. Whether in the military or industry, one learns from experience; and if experience is properly heeded, such benefits can provide for more effective methods for accomplishing the mission or objective. From the development of new weapons and the lessons learned from World War II with respect to tactical employment of troops, aircraft, and naval vessels, the complexion of even the basic unit, the company in the Army, has been changed. With the change in the composition of troop units in the Army, the requirement for logistical support has been changed. For example, with the increased fire power in the elements of an infantry division, specifically because of the increase in the number of weapons and the rapidity of fire, there is an increased demand for the supply of ammunition. With the development and emphasis on mobile type units, there is an additional requirement for more trucks which results in greater demand for tires, repair parts, oil, and gasoline. This places an increased demand on the supply line to support the newly developed combat troop divisions. If we are going to be successful from a logistical viewpoint in supporting troops waging another war, the ability to accomplish this must be woven into our planning patterns now. Better qualified service units, trained and tested in their responsibilities of increased support to the combat troops, must be an integral part of our plans. No longer can staff planners use this formula, given a set Army strength and with requirements for so many combat divisions, the remaining strength is parcelled out to the technical services on this basis, "Now recommend what units you need to do the best support job possible under the circumstances." Rather, there is a need for a set formula which evolves a balanced element of combat and logistical support units which can satisfy both the combat and logistical mission.

New Type Units

New developments and concepts evolved during and since World War II have resulted in a need for new type units. As an example, mention may be made of the field of radiological defense in atomic warfare, in which the Chief, Chemical Corps has a large responsibility. Similarly, the responsibility for the development of and defense in biological warfare has been charged to the Chief, Chemical Corps. The development of new type units requires a consideration of the attendant problems of mission, capabilities, proposed strength, major items of equipment, and zone or zones of operation. When it is realized that the mobilization plan for service support can be put in motion only from the actual program in effect at the inception, it must follow that the chemical support phase of a mobil-

ization program will lag behind the combat element mobilization and subsequent requirements to meet the needs of the combat arms. For this reason, the Chemical Corps has placed the great majority of its non-divisional and logistical support units at the Army Chemical Center. It is hoped that this will serve to keep a specialized technical service, such as the Chemical Corps, in a reasonable state of readiness, and also provide the training nucleus for civilian component units when the demand arises.

Between civilian and combat personnel demands, the extreme technical nature of this problem and the resolution of the conflict between requirements in such a way as to suit all demands is extremely difficult. Since most military planners tend to give greater priority to the combat requirement, the logistical requirement always suffers and we always enter an emergency with the mobilization planning showing an entirely inadequate program for providing logistical support units on a scale capable of supporting the combat units contemplated. It will always be so if, in peace, the planning personnel are predominately of the combat experience type, as is usual, and are allowed to give more authority to their views than is allowed to the few logistically experienced people involved. The result, of course, is that when the war breaks out, we spend most of our efforts on combat unit mobilization and training and usually must hold back the day when we can begin to fight because we are not as well prepared logistically as we are tactically. Experience in two wars tells this story.

Lack of intimate knowledge at staff levels of basic doctrine, responsibilities and functions of the several technical services has, in the past, and since leopards do not change their spots, surely is now complicating the problems of planning for logistical support units. Too often many decisions in logistical support planning would not even have been considered if the planning, reviewing, and approving authorities had had the benefit of the basic knowledge of the special sciences involved.

Achieving a Solution

What is the answer? The solution to the whole problem of logistical support units, which by no means has been outlined here, is far from simple. A simple beginning, however, which might lead to far reaching results in the solution of the whole problem is suggested. First: Get the top level of planners "in line" and by policy statement give impetus to the realization of the importance of logistical support in all phases of mobilization. Second: Organize the planning properly, splitting the planners so as to provide capacity for logistical support planning and assign personnel quantitatively and qualitatively to do the planning. Then name a sufficiently experienced chief with a rank equal to the head of the tactical unit side so that his voice may be heard and respected. This chief and his workers should come from the technical services.

The Army is cognizant of the tremendous contribution that industry has made to the armed forces, particularly in the fields of research and development and industrial mobilization planning. It is necessary that a more comprehensive program of organization for logistical support be developed in order to train more effectively and to utilize more efficiently the services of qualified personnel from industry both in peacetime and in the event of mobilization. This applies particularly in the case of the chemical industry, with its highly trained reservoir of chemists, chemical engineers, technologists, and scientists, whose services would be of tremendous benefit to the armed forces in the practical development and utilization of new type service units required as a result of the latest concepts of warfare. The chemical industry can also contribute greatly in providing qualified personnel to assist in special technical and military instruction given to military personnel in the fields of biology, chemistry, and physics, including atomic fission and radiological survey procedures.

The reader of this short article, especially if he be from industry or the field of science, could well ask the question: "How does this purely military matter, which seems to result from faulty military planning, affect me? I cannot influence it and have little interest in a problem which I can do nothing about." Many of the readers of this magazine are reserve officers of the Armed Forces, however, and as such are interested. When mobilization day comes, if ever again, most of them will find themselves in a logistical support position if not in a logistical support unit.

For the reader who is not a reserve officer, I believe the fact that he is a member of the Armed Forces Chemical Association assures his interest. He would not willingly be a member if he did not feel interested in the Chemical Corps' problems of national preparedness, and a knowledge of all Chemical Corps' problems of national preparedness is essential if the Association is even to begin to accomplish its mission.

ABOUT THE AUTHOR

BRIG. GEN. EDWARD MONTGOMERY

Brig. Gen. Edward Montgomery was commissioned as of December 20, 1911 and has been with the Chemical Corps since July 1, 1925. It is during his years with the Chemical Corps that he served in many important positions, including that of Executive Officer, Edgewood Arsenal and Assistant Executive, Office of the Chief of Chemical Warfare Service. He was associated with the research and development activities of the Chemical Warfare Service on three occasions; first, for two years as Chief of the Technical Division, Office of the Chief, Chemical Warfare Service; then Technical Director, Edgewood Arsenal for three and a half years. He also served as Chief of the Technical Division for a short period, 1942, just prior to going to England as Chief of the Chemical Service, European Theater. He is a graduate of the Command and General Staff College, Chemical Warfare School and the Army War College. He has received the decorations of Legion of Merit and the Distinguished Service Medal for his work during World War II.

SYNTHETIC LIQUID FUEL

TWO COAL-TO-OIL DEMONSTRATION PLANTS ARE PRODUCING LIQUID FUELS FROM COAL ON THE MINIMUM SCALE ENABLING THE BUREAU OF MINES TO MAKE AVAILABLE TO INDUSTRY THE NECESSARY COST AND ENGINEERING DATA FOR COMMERCIAL OPERATIONS.

Under the synthetic-liquid-fuels program of the Bureau of Mines, two coal-to-oil demonstration plants —the first units larger than pilot plants in the United States—are being installed on the site of the Missouri Ordnance Works, a wartime synthetic-ammonia unit made available by the Office of the Quartermaster General. These plants mark a milestone in the steps to a commercial plant and are of marked significance not only to our future economic welfare but also to our future military security.

These plants at Louisiana, Mo., less than 100 miles above St. Louis on the Mississippi River, will produce liquid fuels from coal on the minimum scale that will enable the Bureau of Mines to make available to industry the necessary cost and engineering data for commercial operations.

The two units will employ different processes, one using the direct-hydrogenation or Bergius Process and the other the gas-synthesis or modified Fischer-Tropsch Process.

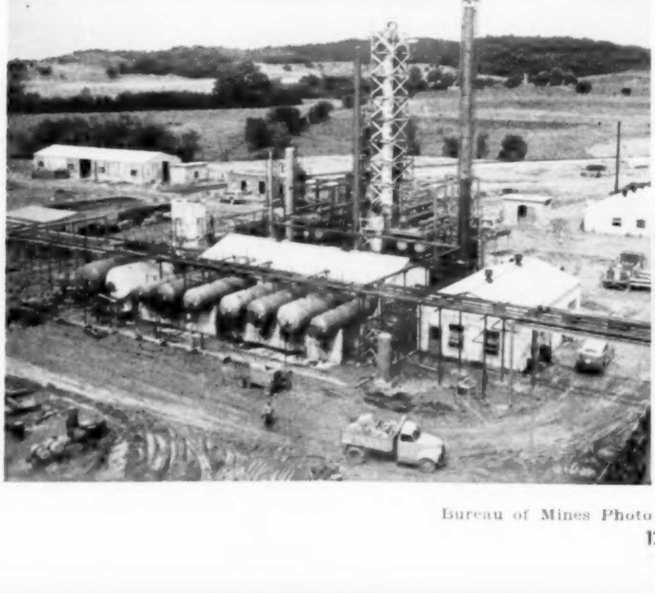
The hydrogenation demonstration plant, dedicated May 8, was designed for operation at pressures up to 10,000 pounds per square inch in two major steps: (1) liquid-phase hydrogenation, which accomplishes liquefaction of coal; and (2) vapor-phase hydrogenation, which converts the liquefied coal to gasoline and by-products. Depending on the coal and catalyst used, the output of the plant will range from 200 to 300 barrels daily.

Although the products of the synthetic-fuels processes being developed by the Bureau of Mines will meet standard specifications for motor fuel or aviation fuel and be interchangeable with the corresponding products from petroleum, the synthetic oils from each of the processes differ somewhat from petroleum and from each other.

The hydrogenation process yields oils that are high in aromatics and cycloparaffins. The gas-synthetic process, on the other hand, yields chiefly paraffins and olefins.

Each of the processes can yield large quantities of chemical by-products; and, as might be expected, the chemical products are quite different for the two processes. From the products of coal hydrogenation, industrially valuable tar acids can be separated. These tar acids contain approximately 20 percent phenol, 30 percent cresols, and 50 percent xylenols. The yield of tar acids increases with decreasing rank of coal. Thus, for high-volatile bituminous coals it is 5 to 7 percent of the moisture and ash-free coal, and for

Distillation unit at Bureau of Mines coal hydrogenation demonstration plant near Louisiana, Mo.



Bureau of Mines Photo

Back of converter stalls, showing traveling gantry crane astride stalls at left. In foreground, left to right, are the high-pressure pump house, instrument house, and heavy-oil pump house of the Bureau of Mines Coal Hydrogenation Demonstration Plant at Louisiana, Mo.

Bureau of Mines Photo

subbituminous coal and lignites, 7 to 15 percent. Coal-hydrogenation middle-oil fractions boiling in the range of 200°C. to 350°C. contain 20 to 40 percent of tar acids. Parts of these fractions could be used directly as "creosote oil" for wood preservation. If tar acids are separated from the middle oils, the remaining neutral oils, which contain 40-50 percent of aromatics and 20-40 percent of hydroaromatics, could be used as solvents and lacquer thinners.

From the higher-boiling fractions of neutral oil, polynuclear hydrocarbons such as anthracene, phenanthrene, pyrene, chrysene, and 4, 9-dimethylpyrene have isolated.

The tar-base fraction of coal-hydrogenation oils amounts to 2 to 4 percent of the moisture and ash-free coal. Comparatively little characterization work has been done, but in the lower-boiling tar-base fraction aniline, pyridine, and toluidines are present in appreciable concentrations.

The Fischer-Tropsch Process yields chiefly straight-chain paraffin hydrocarbons and 5 to 15 percent of oxygenated compounds, mainly methanol, ethanol, propanol, acetic acid, acetone, and acetaldehyde, contained in the aqueous layer of the reaction products. Oil-soluble alcohols and esters are also produced in appreciable quantity, but these normally would not be available as by-products. They would be sent along with the hydrocarbon oils through refining operations that would convert them to hydrocarbons.

As of 16 June the Coal Hydrogenation Plant continued the test work preparatory to the first liquid-phase run. The Coal Gasification Plant had made a few successful runs, one with all six burners. The construction of the Gas Synthesis Plant was progressing on schedule.

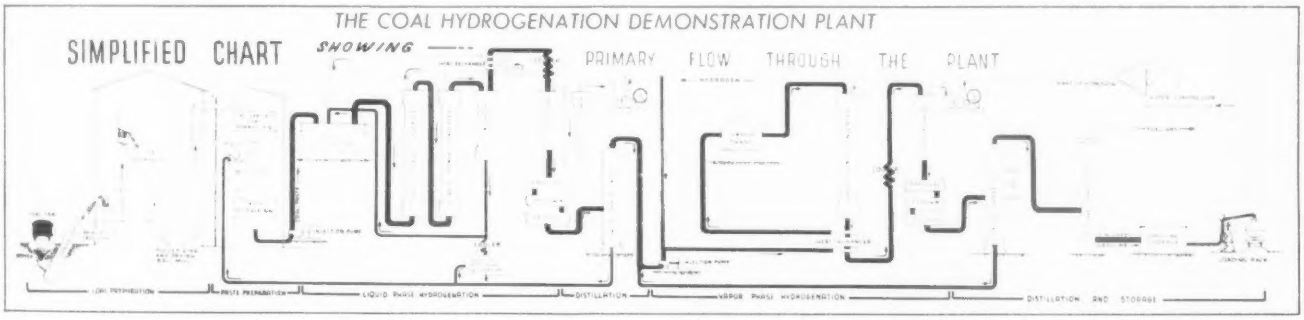
At the request of the U. S. Department of Interior, the Army Corps of Engineers is conducting a nationwide survey to determine general areas where requirements for one or more synthetic-liquid-fuel plants can be met. For use in this survey, the Bureau of Mines assembled and provided data on the basic requirements of cost, construction materials, raw materials, water, and construction and operating manpower for commercial plants of different sizes and types.

A relatively detailed sample survey of only a part of one coal-producing state recently revealed suitable sites (including water and other facilities) for 60 synthetic-fuels plants. This number of plants, during their active life, could produce about 25 billion barrels of oil.

The contract for the more extensive survey has been awarded to Ford, Bacon and Davis and four subcontractors at a total cost in excess of $1,300,000.

* * *

The Armed Forces Chemical Journal is indebted to Dr. W. C. Schroeder, Chief, Office of Synthetic Fuels, and Dr. L. L. Hirst, Chief, Coal to Oil Demonstration Branch, Bureau of Mines, for furnishing the information for this staff report.



NEWS OF INDUSTRY

American Cyanamid Company

The New Product Department of American Cyanamid Company announces pilot plant production of cyanuric chloride. A recently issued thirty-page technical bulletin is available and covers details of physical and chemical characteristics, and uses of its product.

Cyanuric chloride has been used abroad for the preparation of dyestuffs and optical bleaching agents for whitening textiles. The product also offers possibilities for the syntheses of pharmaceuticals, high polymers, explosives, rubber chemicals, mothproofing agents, surface active agents, and plasticizers.

The bulletin will be sent to interested parties upon written request to the New Product Department, American Cyanamid Co., 30 Rockefeller Plaza, New York City.

Mathieson Chemical Corporation

Mathieson Chemical Corp. announces changes in its Sales Department Executive Staff as the result of the retirement of E. E. Routh, Vice President. D. W. Drummond has been named Vice President, Director of Industrial Chemical Sales and S. L. Nevins, Director of Agricultural Chemical Sales.

Other appointments are: J. O. Logan, Sales Manager, Industrial Chemicals; R. J. Quinn, Ass't Sales Manager, Industrial Chemicals; L. P. Thomas, Southwestern Sales Manager, Industrial Chemicals; J. S. Whittington, Sales Manager, Agricultural Chemicals.

Hercules Powder Company

The Advisory Board of the Gordon Research Conference has elected Dr. Charles N. Frey, Director of Scientific Relations of Standard Brands, Inc., and Prof. Herman Mark, Professor of Organic Chemistry, Polytechnic Institute of Brooklyn, to the Management Committee of the conferences. In addition, the Management Committee consists of Dr. Emil Ott, Hercules Powder Co., chairman; K. G. Compton, Bell Telephone Laboratories; S. S. Kurtz, Sun Oil Co.; Dr. Randolph T. Major, Merck & Co. and Dr. H. A. Meyerhoff as the representative of the American Association for the Advancement of Science.

Pittsburgh Plate Glass Co.

A new sludge disposal system that carries plant waste over a mile-long line to a settling basis has been put into operation at the Creighton plant of the Pittsburgh Plate Glass Co. An important step in the elimination of stream pollution, the process diverts the discharge of between 300 and 400 tons of grinding abrasive which formerly poured into the Allegheny river daily. The new sludge disposal system carries 4800 gallons a minute and will handle about 300 tons of solids daily.

A TEXT PRESENTATION

JAPANESE CHEMICAL PLANTS

A report by Mr. Frederick Pope to the Secretary of The Army.

The Department of the Army has recently released a report on the status of the Japanese chemical industry as prepared by Mr. Frederick Pope who was sent to Japan by the Secretary of the Army to survey the chemical industry. Mr. Pope is well known to many of the older members of the Association. He was a Major (CWS) in World War I and served as Assistant Chief of the Chemical Warfare Service in the American Expeditionary Forces in France from 1917 to 1919. He is a former president of the Chemical Construction Company of New York and was prominently identified with the building of the Sumimoto ammonia plants in Japan between 1925 and 1931. During World War II, Mr. Pope was employed as a consultant by the War Department.

1. The Under Secretary of the Army invited me to report on the condition of the Japanese chemical industry. To make such a report I have visited, inspected, and questioned the management of forty-two Japanese chemical plants. I beg to point out what is, of course, self-evident, that it is impossible in a visit of a day or part of a day to gain complete information about a chemical plant. However, it is possible for a person with sufficient background and experience to obtain educated impressions which are, in general correct. The conclusions I have reached are clear to me.

2. The output of basic chemicals is increasing.

3. The cost of production as recorded for each plant is a matter of concern. The general high cost is due, I believe, in most cases to one or two of the following: Poor management; labor costs and conditions; partial operation of the plant because of shortages of power, coal, or other raw materials; mechanical condition of the plants; as well as government or war potential limitation of production.

4. The first and most important deficiency is good top men. It is particularly true in the chemical industry that good men at the top are sine qua non. The poorest sort of a broken down plant with good management is far more likely to succeed than the best up to date plant with incompetent management. That may be called a platitude and true of all industry, but it is peculiarly true of the chemical industry. I feel the chemical companies should search the country for good men no matter how old they may be or what their present circumstances are. Plant and company management, I find, is frequently in the hands of ill-prepared men. On the other hand, some companies are excellently well managed.

5. The next need is money. How money may be had is not my province to say. I do believe, however, that, if a substantial sum of money, even many million yen, were loaned to selected Japanese chemical companies at low interest—say 4½%—for terms varying from five to fifteen years, something between 95-98% (?) would be paid back.

6. The next need is raw material which includes fuel and power. This is a difficult problem, but I believe men and money would solve it. Much sulphuric acid demand could be relieved by using other substances to combine with ammonia in ammonia fertilizers. Another relief would be by using the sulphur dioxide in waste gases now thrown away as, for example, by the Dowa Mining Company at Koseka and the Nippon Mining Company at Hitachi and Saganoseki. A further relief to the sulphur situation would be the use of other carriers of nitrogen; for example, as in the case of urea. It would pay to study the action under Japanese conditions of ammonium chloride, a fertilizer difficult to make and little used. Careful tests might show the usability, under Japanese conditions, of nitrochalk (a trade name for a mechanical mixture of ground limestone and ammonium nitrate). I believe it would pay to make some nitrochalk without awaiting the tests. There are crops—say wheat, for example—on which in most locations nitrochalk might be used. It probably is necessary to obtain authority to manufacture the ammonium nitrate needed to produce nitrochalk. The sulphur situation is of sufficient importance to warrant the conclusion that Japan will probably be obliged to use substantial amounts of ammonium nitrate as such. The way it is used, the form in which it may be used, and how the granules may be covered should be studied earnestly and expeditiously. This should not be done at the expense of any investigations concerning urea or ammonium chloride, but concurrently, and the comparative costs and merits determined.

Photo—U. S. Strategic Bombing Survey

PLANT OF RIKEN METALS COMPANY AT UBE
Rehabilitation of existing facilities should be encouraged.

7. There is no question but that salt is urgently needed. It is brought now from long distances, most of it coming from the Mediterranean and East African points. Formerly a large amount came from China and Manchuria. I wonder if the manufacture of salt in Japan should be encouraged, thus cutting down freight and the exporting of money. The reestablishment of the in-

dustry in Manchuria and other similar places should be encouraged as it would cut down shipping cost, hence the cost of salt, and make payment easier—possibly in goods.

8. The phosphate rock situation is bad. Phosphate rock is being imported from the United States at great expense. If Japanese ships were available, and if the Japanese were permitted to do so, the mining of phosphate rock in the Pacific islands should be seriously considered.

9. Power is really not my subject. However, fluctuations in hydroelectric output have serious effects on the operation of chemical plants where continuous operation is the rule. Therefore, I fail to see why steam plants to even out the supply in times of low water are not more common in Japan.

10. Fuel, too, is not my subject except as it affects the chemical industry. I find that no coal benefaction other than coal washing with water is generally known in Japan. Heavy Media Separation and "sink and float" processes would eliminate up to three-quarters of the ash in most Japanese coals. Were these installed at the mines, it would not only greatly improve the quality of the coal, but also mean a saving in freight of fifteen percent, more or less. It is very clear, that if not at the mines, they should be installed in certain of the chemical plants to improve the usability of the fuel.

11. I have not mentioned research which will be of the utmost importance in the future. At the moment, however, I feel that all Japanese efforts should be placed on the rehabilitation of industry, letting commercial research follow in a year or two.

12. Chemical patents are an essential and important part of any chemical industry. I recall the situation in Germany where the matter is being intensively studied. There German citizens were, as late as last fall, permitted only to file priority dates, which is entirely unsatisfactory to them. I hope that not only will prompt study be given the subject of Japanese patents but that Japanese chemical companies will be permitted to purchase licenses to use American patents.

13. As to reparations, the moving of chemical plants for reparations, can, I think, be explained only as revenge. No chemical plant built by moving the machinery and apparatus from another chemical plant can cost on the average less than 90-95% of the cost of a new plant and the result is a second-hand plant—an abomination if not a liability to any chemical manufacturer. I earnestly hope that this vicious procedure may be stopped. I will mention four instances among many:

a. In one dye plant, the Nissin Chemical Company, Limited, Osaka Plant, there is a plant producing sulphur trioxide. It is, in effect, a part of a ten-ton sulphuric acid plant. It is proposed to move it for reparations. It would cost more to build a new plant by pulling that one down and moving it than it would to build a new complete sulphuric acid plant, and yet, moving that plant, I am informed, would throw two thousand men out of work.

b. Another case, the Asahi Chemical Company, Limited, Nobeoka Plant, away at the southern part of Kyushu, has a small mercury cell caustic plant, part of a large chemical plant—as a unit practically useless to anyone else. To move that for reparations would, I am informed, throw eight hundred men out of work. In that case the caustic and chlorine to be used in the main plant must be brought in from plants located at a distance.

c. Another example, that clearly stands out is the Nippon Soda Company, Nihongi Plant. About ten percent of the value of the plant has been marked for reparations. Be that ten percent removed, it would, I am reliably advised, make the whole plant inoperative except at a loss, thus throwing three thousand four hundred men out of work. Everything they make is founded on caustic soda and chlorine. The plant was started twenty years ago. The village and the surrounding villages are largely dependent on its payroll for their existence. The question immediately arises, why shouldn't the necessary caustic soda and chlorine be imported from other plants? The answer is that it would cost so much that the plant would soon use up its capital and would have to operate on a government subsidy, or not at all. I believe the equipment it is proposed to leave will produce an insufficient amount of chlorine and caustic to permit the plant to operate at a profit. Here is a clear case of, in effect, wiping out a community or paying a government subsidy to meet a conclusion based on an individual opinion.

(Continued on Page 16)

Photo—U. S. Strategic Bombing Survey

ISHIHARA INDUSTRIAL COMPANY PLANT AT YOKKAICHI

The first and most important deficiency is good top men.

Photo—U. S. Strategic Bombing Survey

MITSUI CHEMICAL PLANT—AFTER BOMBING

Recommendation: the moving of plants for reparations be stopped!

JAPANESE CHEMICAL PLANTS

(Continued from Page 15)

d. The other side of the picture is illustrated at the Nissan Chemical Industrial Company, Toyama Plant, where there is a contact sulphuric acid plant that was moved during the war by orders of the Japanese Army. I am told it cost much more to move it than a new plant would have cost and the plant is unsatisfactory. Of course, then they had an excuse—time. It is, nevertheless, a good example of what should not be done. Only thirty percent of the original value could be moved. The cost of taking down, packing and transportation was much more than thirty percent when new.

In all cases of electrolytic caustic soda plants marked for reparations or as surplus, one must consider the possibility of at some time using ammonium chloride as a fertilizer, in which case all of the now surplus chlorine would be urgently needed.

Furthermore, what a field for Communistic agitation! It is known to the workers at the plants mentioned in a, b, and c above that such action is contemplated. They are all worried about their livelihood now and later and wondering if their futures would not be more secure with the Communists who promise them that, if Communism comes in, the plant will be either maintained as it is or restored. Also, uncertainty as to the moving of a plant for reparations is disconcerting to management as well as to the workers.

14. The rehabilitation of existing plants should be encouraged in every way possible. I have seen a number of plants to date still running well but on the verge of breakdown because they have run so long without proper maintenance and repairs. Also, out-moded and uneconomical processes might at the same time be replaced by modern processes at a comparatively reasonable cost.

15. While I understand there are no Fischer-Tropsch or similar plants operating today in Japan, there are partially dismounted plants. Today there is no place for Fischer-Tropsch plants in Japan either from an economic or security standpoint. In one place a Fischer-Tropsch is housed in an exceptionally good building that should be used for some other purpose. The process apparatus should be sold as scrap, salvaging for other purposes all standard machinery and equipment.

16. As a temporary measure, I recommend establishing an Executive Engineering Board in SCAP with an American as the nominal head with veto powers, etc., composed of two first-class Japanese chemical executives; two first-class Japanese engineers; and two first-class American chemical engineers (men competent to earn in the neighborhood of $25,000 a year in America). The object of this board would be to receive each week the most concise report of production, inventory, shipment, and conditions of raw materials, labor and repairs from let us say fifty to sixty Japanese chemical plants. With this information the Board should be able to help a faltering Japanese chemical company to its feet. Before the war the Japanese chemical industry was a successful one. Its routine operation needed no outside help. I feel such a board as this would be unnecessary after say two years. In such period of time it should be able to give the Japanese chemical industry the necessary help and encouragement.

17. The American authorities must be urged to be very sure of their facts before issuing drastic orders that may have a long-time effect on the Japanese chemical industry.

18. It is now impossible for most Japanese chemical companies to get either foreign publications or foreign

(Continued on Page 35)

ARMY EXTENSION COURSES

DESIGNED FOR SPECIALIZED TRAINING, THE EXTENSION COURSE PROGRAM OF THE CHEMICAL CORPS ESTABLISHES A STUDENT PARTICIPATION RECORD IN MILITARY EDUCATION. REVISION OF PROSPECTUS IS ANNOUNCED.

The mission of Army extension courses is to provide a progressive non-resident course of military instruction or personnel of all components of the Army of the United States.

The extension course of each school is divided into six numbered series (10-, 20-, 30-, etc.), according to the grade for which primarily intended, and such special series as may be authorized. The application of the numbered series is as follows:

In general, the 10 series covers precommission basic military subjects in which qualification is required for appointment in the grade of second lieutenant. The 20, 30, 40, 50 and 60 series cover subjects or phases of subjects applicable to mobilization duties of second lieutenants, first lieutenants, captains, majors and lieutenant colonels, respectively, and in which qualification may be required for promotion to the next higher grade, respectively.

The numbered series are further subdivided into subject or study units known as subcourses. The total credit hours of each series subcourse is based on the equivalent of 80 credit hours for each year of the minimum time-in-grade prescribed as a prerequisite for the promotion of Active Reserve officers. Thus, there would be approximately 400 credit hours in the 40 series subcourses, for a Captain must serve at least five years in grade before becoming eligible for promotion to Major.

In general, extension course presentation of a subject will parallel presentation of the same subject in resident instruction with regard to scope and level of instruction.

The extension course program of the Chemical Corps is designed for specialized training in the 30, 40, 50 and 60 series. These training groups have been designated as follows: A—Troop and Staff; B—Technical, Manufacturing, and Inspection; C—Supply and Procurement.

Mobilization assignments are made by Army commanders and may be obtained through Unit Instructors. Upon receipt of this information, enrollees are placed in the training group appropriate to their mobilization assignment.

For example, some subcourses have been designated for all three groups and are marked (A, B, C). These subcourses cover important subjects of general interest to all officers and may be prepared by the Chemical Corps or they may be common subcourses. Specialized subcourses are marked for a particular training group. By employing this system, an officer may still specialize yet receive the training necessary for a well-rounded military education.

In accordance with the approved draft of DA Regulation 350-3000, it will be necessary to revise the prospectus of Extension Courses administered by the Chemical Corps School.

This regulation provides for the number of credit hours indicated below.

	Cr. Hrs. (Not Less Than)	Cr. Hrs. (Not More Than)
10 series	200	250
20 series	150	180
30 series	230	250
40 series	370	400
50 series	230	250
60 series	310	330

Thus, it will be necessary to delete subcourses from the 10, 20 and 30 series and add to the 40 series. Inasmuch as possible, subcourses deleted will be common subcourses, such as Mess Management, and those prepared by other service schools, such as Rifle Company in Attack. Some of the 20 and 30 series subcourses will be placed in the 40 series. It is planned to place the Radiological Defense series subcourses in the "B" training group of the 40 series. A general Radiological Defense subcourse is planned and will be placed in the "A" and "C" training groups of the 40 series. The above changes are tentative and are subject to approval of higher headquarters. The 50 and 60 series deal mainly with tactical and logistical problems and are administered by the Command and General Staff College.

The records of the Chemical Corps Extension Course Branch contain some interesting facts. On 1 July 1948 enrollment was 450; on 1 January 1949, 500; and on 1 June 1949, 951. This sudden increase in enrollment within the last five months can be explained by SR 140-60-1 which announced the "Point System for Retirement Purposes." The number of lessons per student per month jumped from 0.9 for July 1948 to 1.3 for December 1948, to 2.2 in March and 2.84 in May 1949. Since January 1949, the Chemical Corps School has held the honor of first place in the number of lessons submitted per student per month. In order for Reserve officers to obtain the minimum number of points for a satisfactory year of service, it is estimated that the number of lessons submitted per student per month will have to climb to 3.2. Offiers in rural areas will have to rely mainly on extension courses to obtain their retirement credits, while those who reside in or near urban centers can obtain their credits by attending conferences, lectures, drills and contact camps in addition to enrolling in Army Extension Courses.

ACTIVE RESERVE REQUIREMENTS

In a TWX to Army Commanders, The Adjutant General advised of a change in procedure for retention of Army Reserve Officers in the Active Reserve. The new method is based on earning points on the same basis as points are earned for retirement purposes. Effective June 29, 1949, Reserve Officers must obtain 27 points credit yearly, including the 15 points awarded to remain in the Active Reserve. In other words, an officer must earn 12 credit points. These may be earned by active duty periods (one point per day); one point for each training assembly; attendance or instruction at group schools, etc.

THE ATOMIC BOMB AND HAZARDOUS RADIATION

IN AN ATOMIC WAR RADIATION, OR ITS THREAT, WILL BE A DEFENITE PROBLEM TO BOTH CIVILIAN AND MILITARY PLANNERS. HOW WE SHALL MEET THE SITUATION IS DISCUSSED BY A TECHNICAL COMMAND EXPERT.

By
Lt. Col. Donald H. Hale, Cml C.
The Technical Command
Army Chemical Center

It is known that an atomic explosion releases intense radiation at the instant of the explosion and also scatters radioactive materials over a wide area. It is realized that this radiation is a hazard to personnel. The amount of the hazard, however, has been the subject of some acrimonious debate in the public press. It is now known that the blast effect, of the air burst bomb, is a greater hazard than is the radiation.

However, there is a definite radiation hazard and radiation did kill its thousands at Hiroshima. In an atomic war this radiation, or its threat, will be a definite problem to both civilian and military planners. It is the purpose of this paper to discuss the radiation problem which will exist during and after an atomic explosion.

The atomic bomb does not, in the true sense of the word, explode at all[1]. The material of the bomb undergoes fission, or simply "fissions." It is this process of fission which releases the great energy of the bomb and produces the radio activity which is to be discussed.

The fission process is characterized by the splitting of an atom into two atoms the sum of whose masses is nearly equal to that of the original atom. Considerable energy is released in the process. Also, the process releases electromagnetic radiation and the two residual atoms are almost always radioactive. These residual atoms are generally spoken of as the fission products of the fission reaction.

It is now known that most heavy atoms can be made to fission if they are bombarded with energetic alpha particles or deuterons. Thus, Lawrence and his co-workers at Berkeley have made such materials as bismuth and lead fission when bombarded with alpha particles of about 400 Mev (million electron volts) energy. This type of fission, therefore, can only be brought about if one has available a cyclotron or other powerful accelerator. Obviously, this type of fission is useless as a source of great amounts of energy. As a matter of fact, many such fission reactions require so much energy to set them off that the net gain, per atom undergoing fission, is small. Also, when it is considered that not all of the energetic bombarding particles enter a nucleus and cause it to fission, it is apparent that the process is quite wasteful.

What is needed, for the production of energy in large amounts, is a chain fission reaction. Such reactions are possible with a few of the heavier atoms. This type of reaction is utilized in the atomic bomb. Such fission reactions are set off by neutrons[2]. The neutron enters a nucleus of an atom and so disturbs the binding energy which holds the nucleons of the nucleus in position that the nucleus splits, or fissions. The nucleus of the uranium isotope of mass approximately 235 mass units (U^{235}) will fission if it captures a neutron of low energy. The process may be described by an equation as follows.

$${}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{39}Y^{97} + {}_{53}I^{136} + 3\,{}_{0}n^{1} + E$$

It is to be noted that the equation states that the nucleus of the U^{235} atom captures a neutron and fissions to yield an atom of Y^{97} and one of I^{136} plus three neutrons and energy in the amount E. The energy released in this type of reaction is approximately 200 Mev. Actually, the energy release is a function of the ratio of the masses of the two fission product nuclei and may be anything from about 160 to 200 Mev.

If an atom within a mass of U^{235} can be made to fission and one of the neutrons which are freed in the process causes a second atom to fission and this event causes a third atom to capture a neutron and fission, then one has the basis of a chain reaction. Assume that of the neutrons produced in a fission process two succeed, on the average, in causing two additional atoms to fission. Thus, one atom would fission and cause two additional atoms to fission. These two would cause four to fission, etc. Since the time between the series of events is very small this process would establish a fission chain reaction which would build up with great rapidity and which would release a great amount of energy within a very short period of time. This is the process that occurs in the atomic bomb.

It should be mentioned that the fission process which is described by the equation above is only one of a number of possibilities. The two equations below describe other possible fission reactions,

$$U^{235} + n^{1} \longrightarrow Pd^{117} + Pd^{117} + 2n^{1} + E$$
$$U^{235} + n^{1} \longrightarrow Sr^{90} + Xe^{144} + 3n^{1} + E$$

The analysis of the fission products taken from the atomic pile shows that over 200 separate isotopes are present[3]. There is no reason to believe that the atomic bomb fission process produces any smaller number of such isotopes. Three neutrons are not produced in the fission of every atom. It may be assumed that from one to three neutrons are released per atom undergoing fission. It was mentioned above that almost all of the fission products are radioactive. This is due to the fact that their nuclei have an excess of neutrons. Thus, as shown above, Y^{97} is produced in the fission process. However, stable yttrium, as found in nature, exists as Y^{89}. In other words, the yttrium isotope which is produced in the fission reaction has eight excess neutrons. One might

think that this radioactive yttrium would decay to some stable isotope by emitting neutrons. Actually, it does so by emitting energetic electrons which are usually called beta particles. This process, in effect, changes neutrons into protons. The Y^{97} emits an electron and changes into an atom of one higher atomic number; i.e., it becomes an atom of Zr^{97}. The Zr^{97} atom is also radioactive and decays by beta particle emission to become Cb^{97}. This step-wise process is called a decay chain. The decay chain for Y^{79} is as follows,

$${}_{39}Y^{97} \rightarrow {}_{40}Zr^{97} \rightarrow {}_{41}Cb^{97} \rightarrow {}_{42}Mo^{97}$$

The chain ends with Mo^{97} which is stable. Thus, the Y^{97} which is produced in the fission process decays by beta particle emission in three steps. Any excess energy which any of the isotopes in the chain possess will be radiated as a gamma photon. Thus, the chain decay process will be accompanied by gamma radiation. Both the gamma and beta radiations are hazardous.

The time that is required for a radioactive fission product to reach stability is of interest. In the decay chain written above Y^{97} has a half life listed as "short"[4]. This means that it is less than one microsecond. The half life of the radioactive Zr^{97} is 17 hours, and that of the radioactive Cb^{97} is 75 minutes. In general, the fission products have fairly short half lives. However, a few of them have half lives that are measured in hundreds of years.

It is now clear that an atomic explosion will scatter radioactive fission products over a wide area. Also, that while most of these isotopes have fairly short half lives there will be some isotopes present which decay at a slow rate. Thus, it must be expected that there will be radioactivity in the vicinity of an explosion for a long time. The high air burst of an atomic bomb inity of an explosion for a long time. sets up an updraft of heated air which carries most of the fission products into the stratosphere. The actual area contaminated by the fission products may be large, for this type of burst, but the radioactive particles will be so dissipated that the resulting radiation intensity at ground level will be too low to constitute a real hazard with the possible exception of a small area directly under the zero point for the explosion. The surface or underwater burst causes some of the fission products to be trapped. This may lead to hazardous intensity levels in the immediate vicinity of the explosion but the contaminated area will be comparatively small.

There are two other sources of radioactive contamination following an atomic explosion. Not all of the fissionable material in the bomb actually undergoes fission[5]. The bomb material will be either uranium or plutonium and both are radioactive and both decay by alpha particle emission. The alpha particle is a definite biologic hazard. Of the two types of bomb material the unfissioned plutonium constitutes the greater hazard since it has a shorter half life and, therefore, decays at a greater rate than does the uranium.

It was indicated above that not all of the neutrons that are released in the fission process are captured by uranium, or plutonium, nuclei and thus cause fission reactions. Many of these neutrons escape the bomb and reach the earth. These neutrons may be captured by the nuclei of atoms of the materials in the earth or sea. Such capture processes often lead to radioactive products[6]. Thus, the sodium atom in the salt of the sea may capture a neutron and become a radioactive isotope of sodium. The following equation describes the process.

$${}_{11}Na^{23} + {}_{0}n^{1} \rightarrow {}_{11}Na^{24} + E$$

The energy which is released in the process and which is indicated by E in the equation is released in the form of a gamma photon of about 7 Mev energy. The radioactive sodium, Na^{24}, decays by beta particle emission as follows[7]

$${}_{11}Na^{24} \rightarrow {}_{12}Mg^{24} + \text{beta particle} + \text{gamma photon}$$

When an atomic bomb explodes under the surface of the sea most of the neutrons which are set free in the reaction are captured by nuclei of materials in the water in reactions such as the one above for sodium. Thus, at the Baker Day test at Bikini radioactive sodium was formed by the explosion.

If the bomb bursts high in the air most of the free neutrons do not reach the earth and, therefore, the radioactivity due to neutron capture is trivial. For the underwater burst the neutron-induced radioactivity is appreciable but, even for this case, it is much less than the radioactivity due to the presence of the fission products.

The types of radioactivity which have been described to this point are often called "lingering" radioactivity, since the decay processes last for some time. This lingering radioactivity comes from radioactive atoms of three classifications. They are,

1. Radioactive fission products
2. Unfissioned bomb material
3. Radioactive atoms produced by the capture of neutrons by stable atoms present in the earth.

In addition to this lingering radiation there is the so-called "prompt" radiation. This radiation appears during the actual period when the material of the bomb is undergoing fission. This period is very short. However, during this short period the radiation is extremely intense. This prompt radiation actually is composed of two types of radiation as follows,

1. Neutrons. There is a heavy flux of neutrons from the bomb while the fission process is going on.
2. Electromagnetic radiation. The entire electromagnetic spectrum is radiated. Infrared, visible and ultraviolet light rays apear as do X rays and gamma photons.

As is well known, the gamma rays and X rays are definite biologic hazards. Further, during the explosion these are very intense and considerable thicknesses of shielding materials are needed if any adequate protection is to be had. The infrared, visible and ultraviolet radiations are definite hazards, but lightweight shielding is sufficient. Thus, the walls of the average house offer ample protection against the infrared, visible and ultraviolet radiation but offer almost no protection against the more energetic X rays and gamma photons.

Alpha and beta particles and gamma photons are biologic hazards because they produce ionization in tissue. The processes by which these radiations produce ionization in body tissue, or other matter, are complex and will not be discussed in any detail here. Essentially, the energetic particle or photon dissipates its energy, as it penetrates matter, by producing free electrons and positive ions. As a rough approximation, the radiation dissipates 35 ev (electron volts) of energy for each electron set free. Thus, radium decays by alpha particle and gamma photon emission and the alpha particle is emitted with 4.8 Mev energy. This alpha particle produces a total of about $4.8x10^{6}/35$ or 137,100 free electrons.

The alpha particle from radium has a range in air of 3.4 centimeters[8] and a range in body tissue of about $4.4x10^{-3}$ centimeters or 44 microns. But in each case the alpha particle produces a total of 137,100 ion pairs before it comes to rest. Therefore, it produces $137,100/4.4x10^{-3}$ or $3.1x10^{7}$ ion pairs per centimeter of path in tissue.

Due to its short range the alpha particle is not a hazard as long as it is outside the body. If it gains entrance to the body through an open wound or by breathing or ingestion it

(Continued on Page 38)

WE'VE BEEN ASKED

Is it permissable for one on the active payroll of the government to receive retirement pay under Public Law 810?

*Not if the combined remuneration amounts to more than $3000 per year. It is prohibited by the Economy Act of 1932.

* * *

Is AUS service during World War II counted as Reserve service under the provisions of Army Special Regulation 140-60-1 (reserve retirement regulations)?

*Yes.

* * *

After I have completed 20 years of satisfactory service as a Reserve Officer what will be required of me in the line of reserve activity pending reaching the age of 60 years when I make application for retirement?

*After you have accumulated twenty years of satisfactory service, you can remain active in the Reserve and secure additional points until you reach age 60 or you may request a commission in the Honorary Reserves, or you may allow your commission to lapse and you will still be eligible at 60 to receive retirement benefits.

* * *

Is an AUS (ORC) officer in a retired status entitled to Veterans Administration hospital observation and treatment for ailments other than those for which he was retired?

*Yes.

* * *

I wish to convert my National Service Life Insurance. Do I get credit for all the money I paid on my term insurance?

*No, because the premiums paid on your term insurance were required to pay for the cost of the protection afforded. If you convert now, you must pay the full premium required at your attained age for the converted insurance.

* * *

I am a reservist and a full time federal employe. May I accept nondisability retirement pay under Public Law 810 at age 60 and continue as a full time federal employee?

*You cannot receive retirement pay under provisions of Public Law 810 and, at the same time, receive payment from the Government as a federal employee. However, when you give up your federal employment you can receive Civil Service retirement in addition to Reserve retirement.

Social

Miss Barbara L. Greene and Mr. George C. Cusack, Jr. were married on June 25, 1949, at St. Mary's Episcopal Church, Emmorton, Md. The reception following the ceremony was held at the Gunpowder Club, Army Chemical Center. The bride is the daughter of Colonel and Mrs. L. Wilson Greene. The groom, a former lieutenant in the Chemical Warfare Service, was assigned to the Headquarters of Col. Greene's Chemical Section, Office of Military Government for Germany in 1945-46.

BOOK REVIEWS

A TEXT OF COLLOID CHEMISTRY. Harry Boyer Weiser. Second Edition. x 444 pages. John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London, 1949. $5.50.

It is generally recognized that colloid chemistry "is a well established branch of chemistry in its own right and not a chapter listed from physical chemistry." In the ten years that have elapsed since Professor Weiser first wrote his textbook of colloid chemistry, this branch of science may be said to have come of age. The second edition reflects this maturity but the author has retained the classical point of view. After a concise discussion of the colloidal state, the text is presented in five major parts: Adsorption, Sols, Gels, Emulsions and Foams, Aerosols and Solid Sols, and Applications of Colloid Chemical Principles to Contact Catalysis and Dyeing. Members of the Armed Forces Chemical Association, who are particularly interested in the modern aspects of chemical warfare, will find the sections concerned with adsorption (121 pp.) and aerosols (23 pp.) especially valuable. Thirty-five years of Professor Weiser's life have been spent in teaching colloid chemistry to advanced undergraduate and graduate students, and he is eminently qualified to write such a comprehensive treatise as we have here. It is useful not only as a student text but serves as an indispensible reference work to all those who are interested in this branch of chemistry. The format and typography are characteristic of the high quality we have learned to expect from Wiley books.

—L. Wilson Greene.

SHOULD WE GO UNDERGROUND *

SURVIVAL IN ANY FUTURE WAR MAY DEPEND ON HOW WELL THE INDUSTRIAL AND STORAGE FACILITIES OF THE NATION ARE PROTECTED FROM SWIFT, POWERFUL BOMBING. IF WE GO UNDERGROUND, THEN THE QUESTION IS, "HOW MUCH?"

By Lt. Col. J. A. Goshorn

At 0530 on the morning of 16 July 1945, the first atomic bomb was detonated in the middle of a New Mexico desert. Before evening of that same day, the small group of nuclear physicists who had conducted most of the basic research realized that the results of their efforts had many far-reaching implications.

As a result of the explosion from that first atomic bomb and the knowledge obtained from those employed subsequently, it has become a realization of the entire world that the bomb is a strategic, rather than a tactical, weapon. To properly appraise this concept for utilization of the atomic bomb, two basic assumptions must be made.

1. That even though the technical details of the bomb are presently a closely guarded secret, the length of time which this secrecy can be retained by the United States is highly questionable.

2. That any existing defense against the bomb at the present time are practically negligible.

In view of the few recognized defense measures which can be taken to minimize the devastating effects of atomic attacks against this country, many suggestions have been made. These range all the way from dispersing our population at a maximum density of 600 people per square mile to moving a major portion of our large industrial centers completely underground. Either of the two extremes is totally out of the question. A possible solution might be an economical compromise some place in between.

Realistic Approach

However, when we as a nation are faced with the possibility that atomic weapons may be used against us in a sudden, vicious attack, our plans must be realistic. Any atomic attacks by an aggressor against us would most certainly be directed at our steel industry, the backbone of our present economic structure; a large portion of our oil refineries; the motor vehicle industry; and many other strategic industries, such as rubber, precision instrument, aircraft engine, and chemical production. It has been estimated that between 50 and 100 atomic bombs directed at our key industries, which are even more dangerously concentrated than our population, would literally paralyze most of our economic potential.

Further implications as to the destructiveness of atomic attacks may be realized by the fact that any bombs dropped on the Cuyuna and the Mesabi Ranges, which produce approximately 60 percent of the nation's iron ore, would leave the ore radioactive and consequently quite useless. The destruction of the Sault Ste. Marie locks by either atomic or high explosive would mean that 80 to 90 percent of the Minnesota iron ore would be cut off from the blast furnaces, due to lack of adequate transportation.

So it is definitely within the realm of possibility that during the first few hours of an attack by an aggressor we would find a large percentage of our industry seriously damaged, as well as thousands of civilians killed and wounded. It would make little difference whether the attacker used conventional explosives, atomic bombs, radiological elements, huge concentrations of deadly chemicals, or a combination of all four. The targets would be essentially the same.

Having recently completed the second major war within the past quarter century, we know that our industrial production is the greatest single element which will insure our existence either in peace or in war. In World War II, it took us almost two years to reach peak production on many critical war items. How long would it take to reach production if 50 percent of our industrial facilities had to be rebuilt before we could start to attain this goal? Frankly, no one knows, but from past experience it would most probably require considerably longer than in World War II. Realizing this, can we as a nation afford to assume that never again will a few individuals, at the head of a police state, go berserk in their search for power?

When the Compton Commission on Universal Training made their report to the President in May 1947, one of their recommendations was as follows: "The development of new weapons will be of no value unless our scientific progress is matched by industrial readiness for the problems of war that may come without warning at supersonic speed. Weapons that were not in being and in possession of our troops when an aggressor struck would be worthless in inflicting swift retribution upon him or in preventing his approach to our shores. Because of the danger that production centers would be demolished in the first days of war, a start should be made toward decentralizing the most vital plants, and in some cases, toward building underground or otherwise adequately protected facilities. Critical war materials must be stockpiled now, which may be used in the future."

There can be no question about the terrific expense involved in the dispersion of our industrial centers or the construction of bomb-resistant production facilities. To provide a reasonable amount of security for our economic potential, we must thoroughly explore the possibilities of a combination of the two most important and available means, dispersion and underground protection. Neither of these, considered alone and without thorough planning, can present a satisfactory solution.

Expense

When considered in the light of expense, it would be prohibitive to

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place all of our important installations underground. Further, it would be far too costly, as well as impractical, to disperse our existing cities over large areas. To construct buildings with sufficient strength to counter the blast effect of atomic missiles for even a small fraction of our total requirements would be equally expensive and impractical.

It is readily apparent that we most certainly would not scuttle our Navy simply because an atomic bomb might sink one or more ships. Nor, by the same token, would we recommend that our Air Force be demobilized simply because airplanes are shot down or occasionally crash due to mechanical failure. Nor does the Army feel that their task is insurmountable simply because soldiers are killed in battle. In considering the capabilities of the atomic bomb, many experts have propounded the theory that we, as a nation, are absolutely defenseless against its employment. And finally, there are those skeptics who say that the effects of the atomic bomb are so persistent that, even if you are underground, you will eventually become a casualty when you come to the surface. One authority has even gone so far as to assume a situation when an aggressor might detonate only two huge atomic bombs and thus make the United States uninhabitable. This is based upon the supposition that by directing the missiles at central California and northern Oregon, and taking advantage of steadiy prevailing winds blowing toward the east, an enemy could expect to accomplish his mission with reasonable success. The theory behind such employment of atomic energy is that the contaminated winds would carry the radioactive particles across the Continent. The aggressor, however, would have no assurance that these same elements would not have the same effect upon his own country. This is quite possible because the elements released during the Bakini test were detected approximately one week later on the west coast.

True, the problems presented in preparing a defense for the atomic warfare which may confront us in the future are many and complicated. The utilization of underground installations certainly seems to be an answer, in part, to our difficulty. Even if we consider the worst destructive capabilities above ground, there is certainly hope for an initial defense if we can conserve, either underground or by dispersion, sufficient men, equipment, and supplies to launch a successful counterattack.

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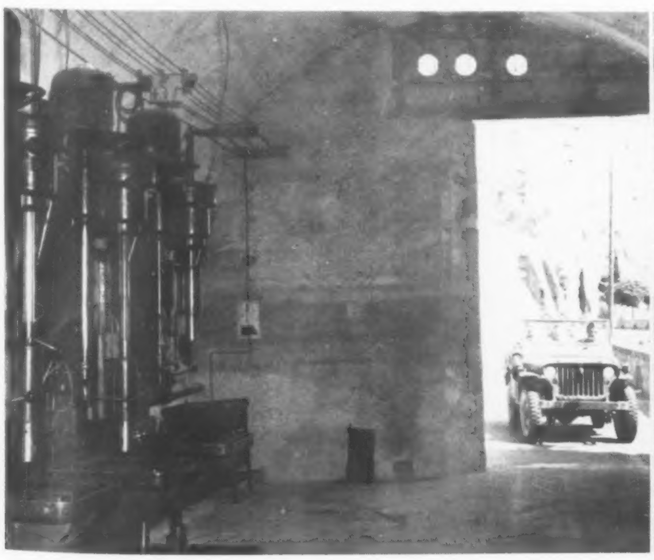

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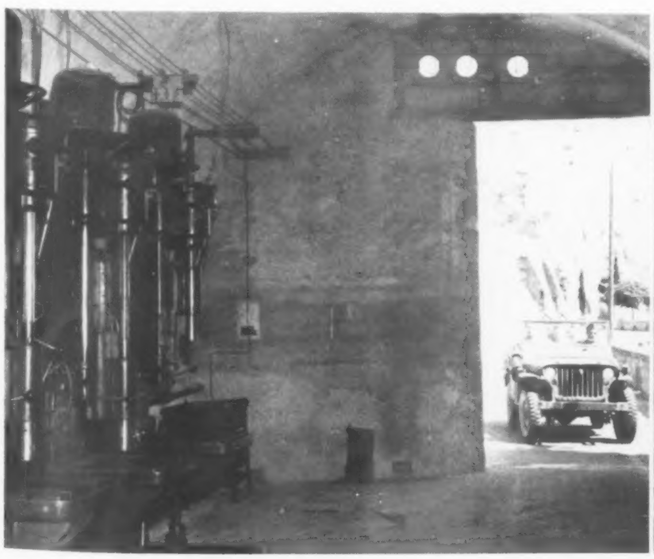

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very few adequate defenses have been developed against it, so far the underground installation seems to be a partial solution. Although we know relatively little from our own experience about the various details of construction and operation of underground installations, a wealth of information can be obtained by inspecting the methods and techniques developed by the Germans. While the Germans never completed a substantial part of their underground program necessary for war production and storage, they had prepared plans by 1944 for placing a large portion of their manufacturing and depot facilities below the earth's surface.

The Germans had very extensive plans for placing their aircraft and synthetic oil industries underground. By the end of the war, they were utilizing underground facilities for the manufacture of aircraft, aircraft engines and accessories, optical and precision instruments, guns, tanks, motor vehicles, electrical equipment, ammunition, V-weapons, and guided missiles. There is no indication, however, that the Germans had made any extensive preparations for placing their heavy industry in similar structures.

The types of underground installations used by the Germans were many and varied. Generally, they attempted to adapt existing facilities to provide for their underground requirements by converting mines, caves, railroad tunnels, and highway tunnels. At a few locations, the Germans had started construction on completely new underground facilities. Generally, these consisted of (1) buildings placed underground with a bomb resistant covering, and (2) tunnels or galleries cut into the side of a hill. The first type involved building a reinforced concrete arch approximately 10 feet thick, with a span from 200 to 300 feet, over a strata of gravel or hardpan. Thus no forms were necessary to support the concrete while it was being poured. After the arch had set, the gravel was excavated to the required depth for construction of the necessary buildings. Structures up to eight stories in height were built of pre-cast concrete columns, beams, and floor slabs under the protective covering. The heating and ventilating systems for this type installation were much more elaborate than those used in converted structures. Finally the concrete arch was covered with several feet of soil and crops planted on top to complete the camouflage.

The second type of new construction was quite similar to methods used in this country for tunneling and gallery quarrying. The principal disadvantage in using this means of construction was that the costs very often were ten times as much as for a surface installation with equal floor space. Costs for this type varied widely depending upon composition of the soil, so the locations of sites were governed by the geology of the area.

German Costs

The Germans developed some interesting figures on the cost of their underground installations. Records indicate that for converting mines, caves, and existing tunnels, the cost varied between 11 and 15 cents per square foot, based on a pre-war rate of exchange of two and a half marks per dollar. For their underground plants, which had to be completely constructed without the use of existing facilities, the average cost varied between 10 and 12 dollars per square foot. For those installations excavated from extremely hard rock and requiring extensive ventilation systems, the cost sometimes ran as high as 35 to 40 dollars per square foot. The above figures may be compared roughly with an average cost of industrial buildings in Germany at the same time of from 30 to 60 cents per square foot.

By the end of the war, the Germans had not accurately developed any definite conclusions as to the thickness of overburden or cover required for protection against the different types and sizes of high explosive bombs. Reports indicate, however, that their first estimates were that reinforced concrete from 10 to 20 feet thick would provide sufficient protection. These estimates were later raised—to between 30 and 40 feet as larger and larger bombs were used. Finally, after the heavy bombing attacks during the later stages of World War II, their engineers concluded that only from 200 to 300 feet of solid rock cover was sufficient to provide adequate protection.

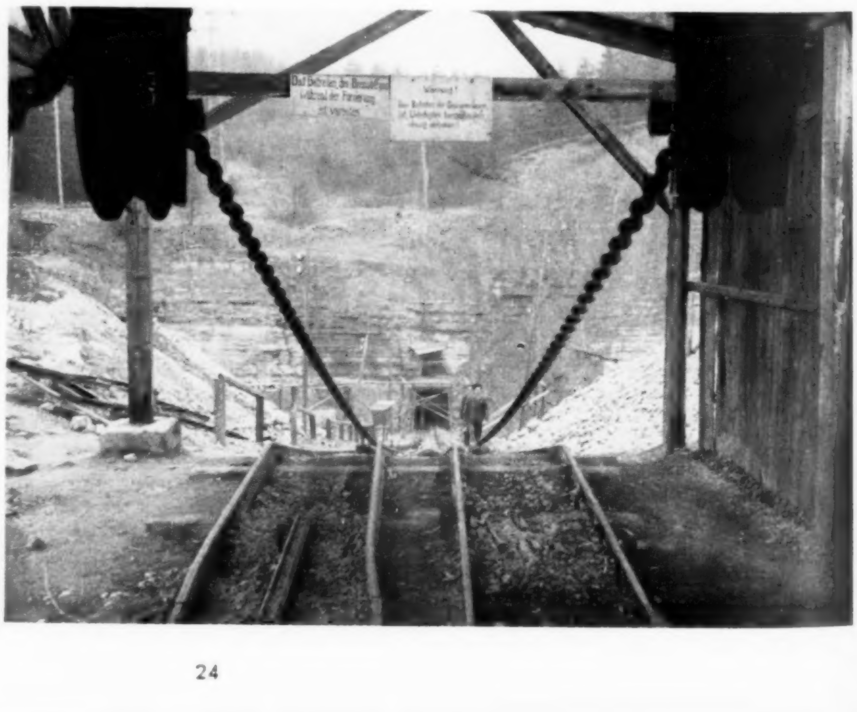
One extremely important and vital lesson should be learned from the German experience. That is, to embark upon a program of "too little and too late" is worse than no program at all. In their final frantic rush for protection from aerial bombing, they used many of their critical materials require elsewhere for the war effort to construct installations which were of extremely questionable value. Faced with a scarcity of strategic materials, in the midst of a major war, it was hardly an appropriate time to rearrange the nation's production and storage program.

Types of Installations

Now let us consider the most elementary type of underground installation. This type consists of pits dug a few feet into the ground. The items to be stored are waterproofed, stacked in the pits, and the excavation covered with earth. The overburden is then topped with a bituminous material to make the storage space relatively waterproof. Several such underground storages

RAILWAY SERVING GERMAN V-1 BOMB FACTORY

The Nazis were exceptionally resourceful in their underground program.



have already been used by our Ordnance Department for the storage of bombs in place of conventional igloos. The advantage in using such a means of storage is that it provides one type of covered storage at an extremely low cost, can be prepared with relatively few construction materials, and is particularly adapted to long-term storage of large quantities of materials which are not subject to deterioration. Such a storage space would also be relatively free from destruction by atomic explosives. Even large quantities of conventional explosives would not be as destructive as would be the case if the items were storeg at ground level.

The next type of underground installation can best be explained by describing a typical installation. This second type is actually a true underground installation except that the overburden is insufficient to give complete protection from high explosive and atomic bombs. An installation which best typifies this category is the natural cooler storage operated by the United States Department of Agriculture in the vicinity of Atchison, Kansas. This storage utilizes a limestone quarry or gallery cave burrowed into a hillside. The storage has a total floor space of 590,000 square feet, averaging approximately 12 feet in height, with a gross volume of approximately 7,500,000 cubic feet. Unminded limestone has been left as pillar supports throughout the storage, spaced at intervals of from 30 to 40 feet.

The overburden for this installation varies between 60 and 100 feet, and consists of limestone and earth. Such a small amount of overburden, however, would hardly give appreciable protection against the larger high explosive bombs.

This storage has been equipped with refrigerating equipment with sufficient capacity to maintain an average storage temperature of 30 to 36 degrees Fahrenheit. This installation represents approximately nine-tenths of 1 percent of the total cooler storage space in the United States. The cost of the installation, less refrigerating machinery and equipment, was approximately one and one-quarter million dollars. Based upon the gross floor area, this is equivalent to a cost of slightly more than $2 per square foot.

The storage has a gross floor area of approximately 15 acres and is all in one large room of polygonal shape, interspersed with approximately 200 irregularly shaped pillars of limestone which support the ceiling. The only interior finish provided was a concrete floor laid over the entire surface, at an average thickness of 5 to 6 inches, which was necessary for the operation of handling equipment. The ceiling was treated with a spray coating of cement and water applied under extremely high pressure to seal off all operings which might permit the entrace of moisture into the storage space. The refrigerating equipment, housed in a building near the entrance, consists of three ammonia compressors, each with a capacity of 250 tons. The refrigeration within the storage space is provided by 48 brine-coil type air units, each having a capacity to circulate 19,000 cubic feet of refrigerated air per minute. The air is further distributed from these units through galvanized sheet metal ducts to provide proper air circulation through the storage space.

The most outstanding feature of this project is the fact that a refrigerated storage space sufficient for 2,600 to 3,000 carloads of perishables was constructed during World War II when there was an extreme shortage of critical materials, yet very few of these materials were used in the conversion of this space. Further, the total cost of construction was only a fraction of what it would have been for a conventional type cold storage built above ground. Although no attempt has been made to camouflage this installation, this feature could be added for a very nominal cost.

V-I MILLING MACHINES IN AN OLD IRON MINE
The factory employed 8000 workers.

Swedish Plant

Now let us consider an underground installation which has actually been constructed to withstand the effects of atomic explosives. Again an actual installation will be used for the purpose of illustration. In central Sweden there is an underground factory excavated deep into a granite mountain which employs nearly 3,000 workers and manufactures diesel and gasoline engines, agricultural machinery, and various machine tools. As you approach this installation, the only man-made structure apparent to the unaccustomed eye is an innocent looking Swedish farm house, located at the foot of a hill. However, when the hinged walls of this house swing open, much like large garage doors, there is an opening of sufficient size to accommodate large trucks. The entrance tunnel has several right angle turns designed to absorb the blast effect of any bomb or explosive which might be detonated near the entrance. Farther along this same tunnel, large, closely fitting, double steel doors provide additional protection against the blast effect from explosives or the entrance of poisonous gases.

The walls, ceilings, and a large proportion of the machinery, are painted a light color to counteract possible development of claustrophobia by the workers. The lighting, a mixture of flourescent and incandescent, produces an effect approaching natural daylight. The air conditioning and air purifying equipment whithin this plant would permit the full complement of workers to remain within its confines for

as long as 36 hours, with all inlets sealed, in the event of an atomic or poison gas attack. Conversely, the entire plant can be emptied of workers, all outlets sealed, and a fire extinguished at any point inside the structure within 5 to 8 minutes.

By careful blasting during construction, a Gothic type arch was achieved. Some of the rooms within the plant are nearly a city block long. The plant is completely equipped for production line methods similar to the large industrial plants in this country. Thus, we see an industrial plant that is as nearly self-sufficient as one can be. The plant owners claim that the construction costs for this plant are approximately 20 percent in excess of normal costs for a similar building built above the ground, and that this particular plant and others of its type will be as much as 10 percent cheaper so far as plant maintenance is concerned over a 30 year period.

Industry and Storage

Let us now consider the possibility of establishing a system of underground industrial and storage installations in the United States. Sometime ago, the Corps of Engineers made a preliminary survey of various caves, mines, quarries, and underground sites for the Munitions Board. Although this survey was only preliminary, it did provide a considerable quantity of valuable data and definite information with respect to location and accessibility of potential underground sites.

For an underground site to provide the necessary protection as well as to be economically feasible as a manufacturing or storage installation, must be capable of properly handling the entrance and exit of personnel, equipment, and supplies. The Germans made one outstanding error along this line in one of their underground factories. At this particular location, it has been reported that as much as one-half of a labor force shift was utilized to transport workers to and from the surface.

Next in the construction of an underground facility, how deep should we go, or how much overburden should be provided if it is to be made relatively safe? Shall the amount of oberburden be in the neighborhood of 300, 600, 1,000 or 2,000 feet? Will a mixture of rock and earth be adequate or will solid rock formations be required? To be on the safe side in answering these various questions, we might assume that an overburden of 1,000 to 1,500 feet of solid rock would be considered safe in the light of present known explosives or those which might be utilized within the foreseeable future.

Next, let us consider a national program for storage installations. Suppose we assume that the open and covered storage requirements for any war in which we may become involved in the future may approach one billion square feet. This amount is in excess of the total military storage requirements in the United States during World War II. Is it reasonable to expect, then, that we may find this one billion square feet of underground storage space in existence today and that it could be readily converted? The answer to this question is definitely in the affirmative. Although some construction work may have to be done to complete certain installations, railroads, and highways, and a rather drastic reorganization effect in our present military storage system, there is sufficient space available. For example, there are not one, but many mines in this country today having a total floor space in excess of a million square feet. True, many of these mines and caves are not totally suitable at present for storage; but given a plan and adequate time for actual conversion, much could be done to obtain this goal of a billion square feet if we start now.

Utilization

How would we utilize this vast amount of space? Is it necessary that the entire amount be underground? Would the additional expense be justified?

Since our industrial potential is so vulnerable to atomic attack, we should have sufficient initial equipment on hand for a balanced M-day force of say, five million men. Naturally this stockpile of equipment must be protected from atomic attack just as our key industries. There should also be in storage a sufficient quantity of those items which require a relatively long time to manufacture. The supply of such items should be adequate to provide necessary replacements for one year of actual combat. Many of these items are available today, but they are not in completely protected storages as they should be. If the items selected are valuable enough to justify retention for a major emergency, then they should not be subjected to loss by surprise attacks.

Finally there is the question of the additional expense. This is like asking a man how much he thinks his life is worth. As long as he is relatively free from danger the amount may be small, but upon the approach of a crises the appraisal of human life seems to be inestimable. So it is with the nation.

What of placing our key industries underground? First, suppose we examine the space requirements for such a program. Let us assume that we need a minimum of 10 billion square feet of floor space. This does not mean that we could put our steel, automotive, or aircraft industries completely underground. It does mean, however, that many of our extremely critical manufacturing processes could be protected by underground installations. A few examples might be the anti-friction bearing industry, optical and precision instrument plants, certain parts of our chemical industry, plants manufacturing critical aircraft components, and our atomic production facilities.

In the location of these underground manufacturing facilities, there are certain basic considerations and requirements which must be met along with the subsurface structure. The first consideration is the

Our Best Weapon

Science has now changed and shrunk the world. No longer are we physically isolated. No longer are we mentally separated from the remainder of this troubled globe. Economic bankruptcy, political discontent, and spiritual despair in far places now affect our daily lives, and may modify the lives and the opportunities of our children. To further complicate the modern scene, the dark and sinister cloud of Communism which has risen in the east has blocked off the sunshine of democratic action and freedom of thought over much of the world. Now it is attempting to extend its malignant influence to our own shores, and to pervert our citizens. For the hopes of men it would substitute despair; for charity it would exchange greed; for freedom, slavery. We must fight it as the scourge it is, wherever we find it, with every weapon at our disposal. We must bear in mind that our best weapon is knowledge, and our army is an informed and articulate citizenry. But we must take care, that we do not use communism's means to combat it, else even if we win we will lose the way of life we seek to protect.

—Dr. David M. Delo

proximity of electric power, fuel, and water. These are basic items required for any manufacturing industry. Next, and possibly one of the most important, is the requirement for transportation. The Germans learned, much to their sorrow, that the destruction of power plants and railroads serving an underground facility considerably lessened its value. Finally, there is the requirement for an adequate supply of skilled labor.

If we require 10 billion feet of underground facilities for manufacturing space, and another billion for storage space, we would probably be approaching very close to the limit of availability. By accurately determining our total requirements and balancing these against the existing sites, in order to keep our costs to a minimum, a comprehensive plan can be developed. Locations for manufacturing sites should be given priority over storage sites. Naturally, the requirements for industrial facilities, if they are to be used in peace as well as in war, are by far the most numerous. A few of the more important of these requirements are accessibility of raw materials, nearness to markets, and the economic feasibility of moving from an existing above-ground plant to a new one underground.

A step in this direction would be for the military to operate a site selection service for certain key industries, just as the Corps of Engineers provides for the Army and the Air Force. Any changes which must be made by private industry must be thoroughly founded on a sound economic return; otherwise the plant will not move.

Returning once more to one of the lessons learned by German industry, these underground plants should at least a two-week back-log of raw materials and maintenance supplies. Plant utilities should also be capable of operating for at least one week without supplies from the outside. Officials of Daimler-Benz stated that "more and more it becomes apparent that even a subterranean plant cannot function during air attacks in a satisfactory way unless it has its own power and water supplies, forge, and foundry."

Conclusion

In conclusion, let us consider some of the principl advantages in the utilization of underground sites for manufacturing and storage. It has been pointed out that underground sites enjoy a marked degree of protection, whether entirely or partially bomb resistant. They are also relatively safe from attacks using poisonous gases. Next, a factory or storage facility completely buried under the ground and with few entrances can be readily protected against sabotage. The very nature of an underground installation makes it difficult to detect and accurately locate from the air. Another advantage, and this is especially true in certain parts of the country, is the protection provided from the elements, such as hurricanes and tornadoes.

There are naturally certain disadvantages inherent to underground installations. The first, and probably the most serious, is the added cost of initial construction, although this is offset by reduced maintenance costs. Second, underground sites which would be advantageous from the standpoint of initial cost and protection are not always located within economic proximity to adequate power and labor sources. There is also a psychological disadvantage, if we attempt to place certain of our key industries and storage installations underground. This is what may be called the "Maginot Line Complex." Underground installations will be used as a reason for complacency by those "Pollyannas" who for so long looked to the oceans on our eastern and Western shores as an excuse for national impotence. Even if a plan for the utilization of underground installations is adopted on a limited scale, we must not believe that we are safe from the surprise attack of an aggressor.

In view of the experience of other countries in the construction and utilization of underground installations, and the present possibility of attacks on our mainland, I leave these questions with the reader: "Should we go underground? If so, how much?"

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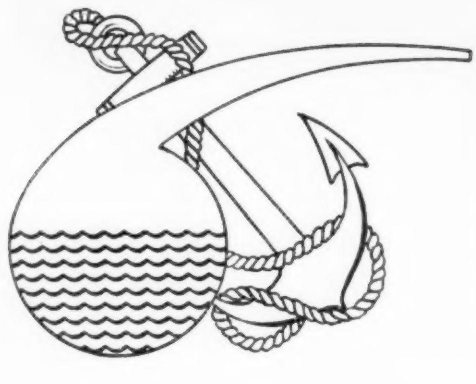
Hobart Publishing Co., Inc., P.O. Box 4127, Washington, D.C., has announced the publication of "The German Chemical Industry. A Bibliography of the Chemical Metallurgical, and Process Industries," by Col. L. Wilson Greene. The book contains more than 2,000 references to reports, translations, published articles, and other documents which give information concerning German chemical technology. The book sells for $7.50 and contains approximately 400 pages. There are over 6,000 entries in the subject index. This is the most comprehensive bibliography of German process information yet published.



CHEMISTRY

IN THE OFFICE OF NAVAL RESEARCH

THE PROGRAM OF NAVAL DEPARTMENT CHEMISTRY RESEARCH HAS BEEN DEVELOPED FROM PROPOSALS SUBMITTED BY SCIENTISTS. THUS, THE SELECTION OF THE RESEARCH PROBLEM AND THE METHOD OF ATTACK ARE THE RESPONSIBILITY OF THE LABORATORY SCIENTIST AND ARE BASED ON HIS RESEARCH INTERESTS.

By Ralph Roberts*

The assurance of the continued growth of the science of chemistry and the interpretation of the new knowledge obtained from basic research for the improvement of the fleet and its air and amphibious arms are part of the responsibility of the Office of Naval Research. Although of great importance to the Navy and the other Departments of the Military Establishment, this program in chemistry will also contribute to the general welfare as research in new directions leads to useful products.

The precursor of the Office of Naval Research, the Office of Research and Inventions, was established in 1945 by executive order of the Secretary of the Navy. The organization was given permanence through Public Law No. 588 which was signed by the President in August, 1946. The enabling act of the Office of Naval Research provides that the purpose is: To plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security; to provide within the Department of the Navy a single office, which by contract and otherwise, shall be able to obtain, coordinate, and make available to all bureaus and activities of the Department of the Navy, world-wide scientific information and the necessary services for conducting specialized and imaginative research; to establish a Naval Research Advisory Committee, consisting of persons pre-eminent in the fields of science to consult with and advise the chief of such Office in matters pertaining to research.

The Offices of Naval Research itself is set up under a chief, Rear Admiral Thorvald A. Solberg, and two deputy chiefs with three assistant chiefs for research, administration, and patents. One of the two deputy chiefs is a civilian scientist, Dr. Alan T. Waterman, with civilian directors who are scientists or specialists, as the duties require, in each group of the organization. The organization of the research group of the Office is shown in Figure 1. This article will discuss the chemistry program of this group which is conducted by contract with various institutions; it does not include the chemical research conducted at the Naval Research Laboratory, a part of the Office of Naval Research. Although the primary responsibility for the chemical aspects of the program is in the Chemistry and Biochemistry Branches, other branches also support research of interest to chemists.

The program of the Office has been developed from proposals submitted by the scientists in which the background, research plans, and possible contributions to chemistry are outlined. Thus, the selection of the research problem and the method of attack are the responsibility of the laboratory scientist and are based on his research interests. The primary requisites of the proposals considered by this Office are that they show promise of advancing scientific knowledge, and are related to the needs of the Navy.

Chemistry Program

The program of the Chemistry Branch includes over one hundred seventy projects at over eighty academic and other institutions in the country. In the evaluation of these projects the Chemistry Branch has been assisted by three advisory panels, one in each of the following branches of chemistry, inorganic, organic and physical. The names of the panel members have been published.[1] The panel chairmen are Dr. W. C. Fernelius, Pennsylvania State College; Dr. F. A. Long, Cornell University; and Dr. M. S. Newman, Ohio State University.

Since the program emphasizes the basic aspects of the science, the research contracts are primarily with universities and colleges, but includes industrial and governmental laboratories. Over 200 senior scientists and 300 post doctorate and graduate students cooperate in the program of the Chemistry Branch. To include all research of interest to chemists in the program of the Research Group this figure should be increased by at least fifty per cent.

Although the Chemistry Branch program has been subdivided into ten fields, electrochemistry, inorganics, explosion and combustion polymers, organics, kinetics, surfaces and colloids, thermochemistry, bioprocesses and special problems, it is best to discuss the entire program in accordance with the disciplines of the science. It would be inappropriate to present in detail the individual projects but an attempt will be made to point out some of the important problems being studied, the results to date, and where possible, some of the potential applications of the new chemical information being obtained.

Inorganic Chemistry

The inorganic chemistry program is concerned with increasing the chemists' knowledge of some of the less familiar elements, the study of new or poorly understood bond types in inorganic molecules, and the mechanism of inorganic reactions. In gen-

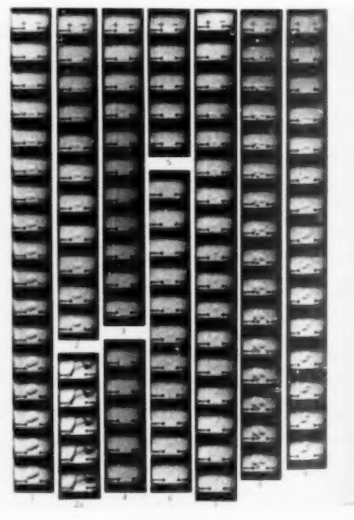


FIGURE II
Development of a Flame from a Spark Ignition Source

This photograph is used with the permission of the Bureau of Mines, U. S. Dept. of the Interior.

[1] *Chem. and Eng. News* 26,1133(1948).

*Mr. Roberts is affiliated with the Office of Naval Research, Department of the Navy.

eral, this field of chemistry has been largely neglected and the present expanding interest may be directly related to the recent developments in atomic energy. The need for separating and identifying fission products, of techniques for producing high purity materials, and of new materials for higher operating temperatures are among the stimulating factors for this field.

The investigation of the properties of some of the less familiar elements, such as gallium, indium, hafnium, tantalum, columbium, and germanium and the rare earths are being conducted at various institutions. Newer methods and the adaptation of old techniques to the isolation of elements from chemically similar ones are receiving considerable attention; ion exchange, liquid-liquid extraction and volatile metallo-organic compounds are among these. A successful method for the separation of thorium from the rare earths has been developed at the University of Illinois.

Inorganic compounds with unfamiliar bond types are of considerable interest. The properties of substance containing the boron-nitrogen linkage are being studied at the University of Southern California and Cornell University. Derivatives of diborane which are believed to contain nitrogen or chlorine in the ring, such as dimethylaminodiborane and monochlordiborane have been prepared. The latter compound has been found to be too unstable for structural studies. B-trichloroborazole, has been prepared at Cornell University and, because of its reactivity, promises to be a precursor of new and interesting substances. Other unexploited inorganic bond types such as N-disilyl aminoborine, alkali and alkali earth

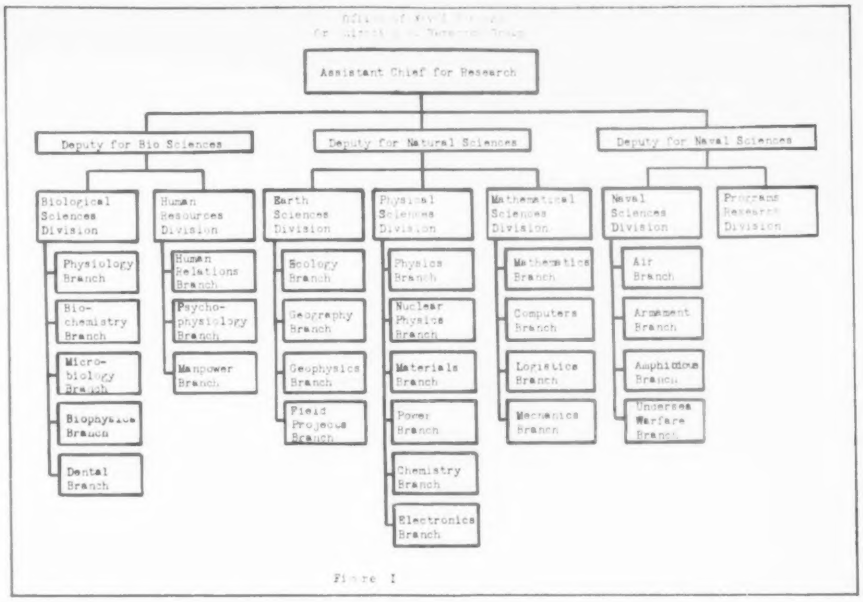


Figure I

phosphides and compounds resulting from reactions between alkali metals and carbon monoxide are under study. The compounds ClO_4F[2] and CF_3OF[3] have been prepared and are the first compounds to be synthesized, with the exception of fluorine oxide, having the OF bond.

More closely related to the applied aspects of inorganic chemistry is the program of the Materials Branch on ceramics and related materials. Studies on the high pressure thermal synthesis of fluorine phlogopite mica from its components have successfully been carried out. The material so synthesized offers a promising source of a substitute for natural mica in some of its applications. Studies on the physical chemistry of pure refractory oxides, borides, carbides, nitrides and phosphides have as their broad objective the obtaining of knowledge on which the development of new and improved refractories may be based. Included in this program are studies on glass and the physical chemistry of metal-ceramic combinations. These studies on ceramics, together with studies on the chemistry and metallurgy of metals resistant to high temperature, are essential to future advances in gas turbine and other power developments.

Studies on the composition, phase relationships and other properties of silicates, aluminates and other rock forming materials are part of the program in geochemistry being supported by the Geophysics Branch. The investigation of color and fluorescence of natural and synthetic minerals to determine why cobalt does not occur in nature in the four coordinate forms is included in this program.

Organic Chemistry

The objectives of the organic program are the synthesis of new organic structures, the development of new synthetic reactions, the determination of structure of complex organic molecules by degradation and synthesis, and the study of organic reaction mechanisms.

During the recent war much effort was expended on the development of organic compounds containing fluorine as the source of chemically resistant lubricants, packing and gaskets. Several of the contractors are making further studies on the preparation and properties of fluorine containing compounds and the relationship of number and position of the fluorine sub-

[2]Rohrbach, G. H. and Cady, G. H. [J.Amer. Chem.Soc. 70,2603(1948).]

[3]Kellogg, K. B. and Cady, G. H. [J.Amer.Chem. Soc. 70,3986(1948).]

FIGURE III
Discussion at Recent Fluorine Conference
Dr. J. R. Nielsen, U. of Oklahoma, and Dr. J. R. Lacher, U. of Colorado, standing.

stituents to the chemical behavior of organic fluorides. The perfluorinated derivative of methyl mercaptan has been prepared at the University of Washington and its composition is believed to be CF_3SF_5. Diamagnetic susceptibility studies at the University of Colorado have given evidence of the relationship of the number of fluorine substituents and the reactivity of fluoro and chlorofluoro ethylenes.

Studies on the synthesis of new ring structures such as spiranes containing one or more cyclobutane rings, tetramethyl cyclobutadiene and cyclooctatetraene are being conducted at various universities. Research on compounds related to cyclooctatetraene, at the Massachusetts Institute of Technology, has led to the preparation of an eight-membered ring dimer of chloroprene. The determination of its structure by ozonolysis has led to the conclusion that it is a head to head dimer of the following structure:

$$
\begin{array}{ccc}
 & H_2 \quad H_2 & \\
 & C — C & \\
Cl\text{-}C & & C\text{-}Cl \\
HC & & CH \\
 & C — C & \\
 & H_2 \quad H_2 & \\
 & \text{IV.} &
\end{array}
$$

The chemistry of cyclooctatetraene promises to be of much future interest since the raw material, acetylene, is readily available.

Studies on the structure of naturally occurring complex organic molecules are being investigated at several institutions. A group at the University of Oregon is studying some of the chemical aspects of genetics and are attempting to separate the color factors of the eye pigments of the Mediterranean fruit fly (Drosophila melanogaster) by the use of chromatographic techniques. The determination of the structure of certain phospholipides of plant and animal tissue is in progress; likewise that of emetine, a naturally occurring alkaloid, which is a specific cure for amebic dysentery.

The use of kinetic data in the determination of the mechanism of organic reactions has increased during the past decade and these studies together with those on the relationship between structure and reactivity form part of the field of physical organic chemistry. Since such studies assist in the determination of the conditions necessary for carrying out organic reactions, advances in this field will lead to improved synthetic methods. This aspect of organic chemistry is being emphasized as it is not possible to predict, at this time, which organic molecules will be of interest or needed in the future and it is believed that advances in this field will facilitate the synthesis of specific structures, once the desirability of having these compounds is established. Rate studies on the dehydrohalogentation of the p,p'-1 dichlorophenyl ethanes, containing one, two or three chlorines in the alkyl group, which were reported at the spring 1949 San Francisco meeting of the American Chemical Society, are aiding in the understanding of the important insecticide DDT. These studies were conducted at the University of Colorado.

The use of radioactive carbon in the study of organic reactions is being conducted at the Massachuettts Institute of Technology. This is a part of the Nuclear Physics and Chemistry program of the Nuclear Physics Branch of the Office of Naval Research. The use of radioactive carbon in the study of the structure of dimers of monosubstituted ketenes by their hydrolysis has led to the postulation of the following as the most probable structures for these dimers.[4]

$$
\begin{array}{ccc}
RCH{=}C{—}CHR & \text{and} & RCH_2C{=}CR \\
| \quad | & & | \quad | \\
O{—}C{=}O & & O{—}C{=}O
\end{array}
$$

Current studies on carbonium ion reactions of t-amyl derivatives, having a methyl group with a radioactive carbon, indicate that the usual liquid-phase reactions do not involve drastic skeletal rearrangements of carbon atoms.

Biochemistry

For the purpose of programming the field of biochemistry has been divided into nine convenient categories, each constituting a specific military as well as scientific interest. The categories range from developmental to theoretical biochemistry and from inorganic to organic and physical biochemistry. The programs include clinical biochemistry, inorganic and electrolyte biochemistry, carbohydrates and lipid metabolism, protein and amino acid chemistry, enzymes, hormones and vitamins, chemotherapeutic agents, immunochemistry, energy metabolism and physical biochemistry.

To mention a few of the projects, the University of California is investigating the distribution of gases, water and electrolytes in the human body, a study which emphasizes the absorption and release of carbon monoxide by tissues. At the University of Oregon research on the biological synthesis of lactose has succeeded in synthesizing this sugar through the use of an artificial enzyme system and minced guinea pig mammary gland. A project at the University of Texas is investigating the biologic synthesis of the cellulose molecule by means of solar and other forces of radiant energy. This problem is related to the development of artificial fiber material. Research on the composition, structure and synthesis of proteins, protein polymers, and amino acids, a study that will add to our knowledge of procurement of human and animal foodstuffs synthetically as well as assist in developing better blood fractions and substitutes is in progress at Columbia University.

A study of the interrelationship in the metabolism of hemoglobin, myoglobin, and the cytochromes is being conducted at the University of Pennsylvania. These substances are all derived from a common iron bearing pigment, heme. The Worcester Foundation for Experimental Biology has been studying the relationship of the adrenal hormones and potassium ions to mental fatigue. Such a study may develop methods for the selection of military personnel for occupations involving considerable mental stress situations such as flying modern aircraft.

At the Scripps Metabolic Clinic in California the action of fluorinated hydrocarbons on living enzyme systems is being investigated. In general the organic fluorides inhibit one or another enzyme system necessary for the maintenance of life. The University of California is conducting a study on the theory and the mode of synthesizing biologic antagonists—agents that block living enzyme systems in bacteria, plants and animals. The project has disclosed numerous drugs of chemotherapeutic benefit and has revealed numerous ways of changing metabolites, like amino acids and vitamins into toxic agents.

At New York University research is in progress on oxidations and syntheses in the carbohydrate breakdown and utilization by tissues. The University of Indiana has a project to investigate organic acid metabolism in the living cell. Both of these studies are very imaginative and describe the activity of specific enzyme systems in the breakdown and utilization of foodstuffs within the individual cells, microbial and mammalian.

At Smith College two physicists are studying the physical chemistry of large molecules, insulin, hemoglobin, and other organic constituents of

[4] Roberts, J. D. et al. J.Amer.Chem.Soc. 71,843(1949).

protoplasm. The cage hypothesis of crystalline protein structure is being developed and the analysis of ultra violet absorption by hydrogen bridged molecules, and vibration-dissociation energies of polyatomic molecules is in progress. Research on the kinetics of energy metabolism is being conducted at Catholic University.

Macromolecules

The Program of research on macromolecules includes the chemistry and physics of natural and artificial polymeric materials and responsibility for this field is shared by the Chemistry and Materials Branches of the Office. Studies on the theoretical aspects of the initiation, propagation and mechanism of polymerization reactions and the relationship between structure and physical properties have been undertaken. On the more practical side polymers with increased surface hardness, materials with better high and low temperature properties, and flame and heat resistant plastics and textiles are being investigated.

The decomposition of diacyl peroxides and of aliphatic azo nitriles used in the initiation of polymerization are being studied. The latter has proved to be of interest also to the utilization of blowing agents in the production of plastic foams. The effect of structure on the relative rate of reaction of monomers in the formation of polymers has been studied at the Polytechnic Institute of Brooklyn.

Research at the U. S. Rubber Company has shown that in the polymerization of vinyl acetate the radical of the monomer is relatively unreactive whereas the polyvinyl acetate radical is highly reactive. On the other hand, the radical of styrene is highly reactive but the polymer radical is quite stable. This explains the greater rate of growth in the polymerization of polyvinyl acetate.

Studies in the field of structure of macromolecules include the investigation by light scattering of the relative mobility of various polymeric materials being conducted at the University of California, the study of the materials at the University of Notre Dame and the study of mechanical properties of high polymers at Pennsylvania State College. The theoretical study of the relationship between structure and properties of polymers, using punched card techniques, is being carried out at the Arthur D. Little Company. From these studies it is hoped to be able to predict polymer types most likely to have desirable properties.

Studies on improving the surface hardness of methyl methacrylate polymers are being conducted at the University of Chattanooga. Definite improvement of the surface has been obtained by reacting the hydrolyzed surface of the polymer with metallic salts. The use of electron diffraction to determine the structural degradation of thin polymer films exposed to the weather is being investigated at the Battelle Memorial Institute.

In the field of textiles and fibers, studies at the Fabric Research Laboratories include the determination of the mechanical properties of hard fibers and yarns, the mechanical properties of strands and high construction fibrous materials, and the properties of ramie. Investigations of textile fiber structure by density measurements are being conducted at the Institute of Textile Technology. Results show that the cellulose of the round-fibered cotton is more dense and less porous than the flat fibered cotton, the fibers of which consist mainly of a primary wall with little secondary thickening. In addition to this work, studies on textiles, wood and lignin are included in the overall program.

Explosion and Combustion

The research on explosives phenomena is primarily directed to the determination of the conditions under which deflagration changes over to detonation, the initiation of explosion and the improvement in the equation of state for gases in the detonation wave. Dr. G. B. Kistiakowsky of Harvard University has proposed that molecular explosives have a "critical mass." This is not accurately predictable as it depends on the shape, size and confinement of the powder and varies from a fraction of a gram in the case of mercury fulminate to the order of hundreds of tons in ammonium nitrate. The research in this field includes studies on shock waves in pure gases with the objective of improving the equation of state for these gases under the conditions existing in a shock wave. The Bureau of Mines is attempting to obtain more accurate measurements of the temperature in detonation waves in order to improve the equation of state for the products of explosion under the conditions existing in the wave. The method is to compare the spectral intensities at different wave lengths of light, measured simultaneously, so that several check calculations may be made from a single experiment.

Studies in combustion are included in the program of the Chemistry and Power Branches. They vary from the investigation of minimum ignition energy for the initiation of stable flames to the study of burning in practical devices. Studies on the relationship between minimum ignition energy, the velocity of flame propagation and the composition of the fuel, oxygen, diluent mixture have been conducted at the Bureau of Mines. Fig. II shows photographs of the development of a flame from a spark ignition source. It has been found that over eighty per cent of the available spark energy is transmitted to the surrounding atmosphere. The measurement of the absolute rate of flame propagation and the structure of laminar flames are also being conducted.

One of the fundamental problems in the field of combustion is whether the scale and intensity of turbulence, the aerodynamic factor, or the rate of flame propagation, the chemical factor, determines flame stability in turbulent flames. Investigations on this problem are proceeding at several institutions. The group at New York University has shown that the increase in the rate of flame propagation, when a flame passes through a grid, is probably due to the increase in surface caused by the breaking up of the flame front as it passes through the grid. Combustion chamber studies at Purdue University have shown that highly turbulent flames can be stabilized by a secondary pilot flame at the periphery of the primary combustion zone. The higher the degree of turbulence within the primary fuel-air mixture, the greater the heat release in the pilot flame must be for the maintenance of a stable burning.

A very important aspect of the research in combustion is the extension of old techniques and the development of new ones for studying the reactions in flames. Spectroscopic techniques are being used by several investigators for this purpose. A spectrophotometer capable of measuring the radiant energy due to various radicals present in 0.1 sq. mm. of the flame has been developed at the University of Delaware. It is possible to either scan the spectrum at a fixed point in a flame or follow the intensity due to a given radiating species by traversing the flame. The Cornell Aeronautical Laboratory has developed a probe capable of withdrawing samples from systems at temperatures up to approximately 1500°C rapidly enough to avoid a shift in equilibrium. The use of various photographic techniques, such as direct, shadow, Schlieren, stereoscopic Schlieren, and high speed photography for the study of flames are be-

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Physical Chemistry

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On the more theoretical aspects, studies on hydrogen and deuterium overvoltage on various metals as a function of temperature and pH are being conducted to help clarify the present theories of this phenomenon. The effects of ultrasonic vibrations on hydrogen overvoltage also are being investigated. Thermodynamic studies of the electrical double layer, based on measurement of the capacity of the double layer surrounding a drop of mercury are in progress at Amherst College. The measurement and determination of the nature of the potential existing between a metal and a solution containing no common ion of that metal are the objectives of a project at Clark University. Studies at Duke University on polarization phenomena occurring in practical electrode systems, which were recently reported at the meeting of the Electrochemical Society, indicate that it may be possible to relate the observed experimental curves with the current efficiency and the effect of current on the capacity of battery electrodes.

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College the preparation of optically active adsorbents has been undertaken to determine their utility in the resolution of racemic mixtures.

Nuclear and Radiation Chemistry

The fields of nuclear and radiation chemistry have grown in importance because of the impetus of atomic energy developments. The first of these treats of such problems as general studies of radioactive materials and counting techniques, the development of methods of separating radioactive materials from targets which have been bombarded with high energy particles, the preparation of carrier free radioactive elements or comounds, the determination of fission yields with interest in the problem of the distribution of nuclear charge in fission; and the chemical nature of the products of nuclear transformation. The second, radiation chemistry, is the investigation of chemical reactions induced by high energy particles, such as gamma rays, alpha and beta particles, deuterons and protons and by high energy atoms or ions resulting from nuclear decay, such as recoil atoms.

The research in these fields is being conducted primarily at the Laboratory for Nuclear Science and Engineering at Massachusetts Institute of Technology and the Institute for Nuclear Studies at the University of Chicago. The first of these institutions is studying the relative efficiency of various aromatic compounds as phosphors for scintillation counters. It has been made of the energy of beta rays from radioactive cobalt which is being used as a standard source of radiation. The extension of the use of electrodeposition to the separation of carrier free-tracers, previously developed by one of the research group, is being conducted to obtain electroytic information about a number of different elements. These data will be useful to both analytical and physical chemists. An ion-exchange method has been developed for the separation of radioactive phosphorous from an iron-phosphorous cyclotron target. Over 99 percent of the active phosphorous is recovered. A method of separating radioactive sodium from a magnesium target without the use of carriers has been developed. The procedure is based on the use of zinc uranyl acetate.

The above is a general description of some of the program and many of the details have been omitted. However, they will become available as the results of the research are published in the various scientific journals. Such publication is encouraged by the Office of Naval Research as it believes that our national scientific growth depends upon the dissemination and exchange of research results and ideas. In addition, the Office of Naval Research sponsors conferences, varying from small groups of contractors to large symposia, to enable the scientists to exchange and discuss their latest research results. Several such conferences have been recently held by the found that mixtures of anthracene in naphthalene are highly efficient for counting. Attempts are being made to determine the radiation characteristics of radio-active europium isotopes which are formed by neutron bombardment of natural europium and which occur in the fission products of uranium. Studies have been various branches of the Office. Of special interest to chemists are those on "Titanium" and "Fluorides and Fluorocarbons," see Figure III.

Significent yields from these basic studies are already becoming apparent and they are sure to increase as the program progresses. They are made possible by the Office of Naval Research through its support of the scientific talents of men primarily outside of the military establishment, in academic, industrial and other non-military laboratories. While every effort is being made to reap the benefits of this research for the National Military Establishment, with so many elements bringing their talents to bear on these problems, their work is bound to enhance the common good. The Office of Naval Research hopes that the results of the program will be used as widely as possible throughout the country. It also desires the active interest of all chemists in this program, even though they may not be direct participants in the research undertaken.

BIOLOGICAL WARFARE

A POSSIBLE FIRST TARGET

A graphic picture of one form of bacteriological warfare might take against the United States in another war was painted for the Senate Appropriations committee by Agriculture and Army officials during hearing relative to the establishment of an elaborately isolated island laboratory to tackle the question of a cure for animal foot-and-mouth disease.

The attack won't be the sudden death of humans through some mysterious plague; merely the ravaging of the nation's food supplies and the wrecking of the whole system of feeding and marketing cloven-hoffed animals through the spreading of foot-and-mouth disease.

Col. A. T. Thompson, Army secretary of the Committee of Biological Warfare, told the Senate group, the War Department "was quite concerned" about foot-and-mouth disease in World War II and had laid plans with Agriculture officials, if the disease should break out, to salvage some of the diseased animals for badly needed food.

An Agriculture scientist, Dr. Bennett T. Sims of the Animal Husbandry Bureau, asserted, "it would be absolutely impossible to keep out foot-and-mouth disease if an enemy country really wanted to spread it through sabotage.

"It could come in a bottle all sealed and marked 'perfume' on the outside, but inside there could be foot-and mouth disease virus.

"Then the virus could be taken to some point in this country and inoculated into guinea pigs and into calves, and within a few days there would be enough virus so that it could be spread all over the country and inoculated into animals in 10 or 20 or 30 states at the same time.

"A man," Dr. Sims added, "could walk through the stockyards in Chicago or East St. Louis and spread the virus."

The American system of moving cattle from grazing to feeding to marketing places would break down in such a case, for all movement of cows or hogs from infected areas would stop.

The Senate voted the money for establishment of the laboratory!

JAPANESE CHEMICAL PLANTS

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advice as they lack the necessary foreign exchange. Chemistry has to go ahead or go backwards. There is no such thing as standing still. This outside help and outside information is a necessity.

19. I believe that Japanese salesmen should be permitted to go abroad in the near future anticipating the export of such pharmaceuticals, dyes, and other chemical products as may soon be exported. To defer sending salesmen abroad until the exportable products are on hand seems a poor policy. Japan will have more than ordinary resistance to the sale of her products due to the hate built up in various parts of the world. Her highest possible caliber of men must pave the way in many of the countries to which Japan would naturally export.

20. The question of ships is very distinctly not part of the chemical industry, but on the other hand, transportation of raw materials and finished products is an essential factor in the chemical field. Some of the lowest class war-time merchant ships laid up at home, if chartered to the Japanese and run by Japanese crews, could make a lot of difference in the cost of importing salt and phosphate rock, moving coal between the islands, etc.

21. The condition of Japanese chemical plants is not very good, with two or three outstanding exceptions. We saw one plant that would be a model plant anywhere. We saw some plants so bad as to be pathetic. The machine shops connected with the various plants vary widely. Most of them are good. Some of them have foundries. The Japanese mechanics, I have observed over years, are, in general, very good. Lighting and safety precautions are in most cases woefully poor. Adequate light should be installed. The same is true of safety precautions. Stair rails, belt guards, covering of holes in the floor, etc., are necessary.

22. In practically all the Japanese plants there is a vast amount of rusty iron scrap; some neatly piled up, some spread throughout the plant. This scrap has a very real cash value which is lessening as the scrap market goes down and the quality of this scrap deteriorates. The scrap is frequently a very real detriment to the operation of the plants. It is often in the way. It occupies space that could be used for useful purposes and it has, without the slightest doubt, a bad psychological effect on the workers. It is important that workers should feel that they are working in a well-managed, business-like plant and put them into a disorderly area is wrong. I would like to see the chemical plants encouraged in the removal of th· scrap, possibly by a central purchasing bureau. If possible, means to force the chemical plants to clean up scrap should be used if they will not do it otherwise. It might be necessary to have a traveling bailing machine or traveling shears, either of which could be mounted on a flat car. I really know nothing about the scrap business. These remarks are from the point of view of a manufacturing chemist.

23. Something must be done about the allocations made by the Japanese Government. There is, I believe, unmistakable evidence that there is a great deal of favoritism and even dishonesty in the matter of allocations.

24. Communistic tendencies in the workmen are creating an increasingly bad situation. In considering only the labor in chemical plants, the advantages of something in the nature of a community center occurred to me. This more properly comes under the scope of Civil

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The Industrial Rubber Goods Co.
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Education and Information, or possibly Public Health and Welfare, than under the chemical industry. However, I have made some observations which are contained in Appendix D.

25. There is weakness in many of the new directorates where unions have a hand in the election of directors. Some theorists may favor it but it is wrong in theory. I am told there are some cases where it has been tried and abandoned. Such directors are interested only in appeasing the unions. Frequently directors now representing new shareholders have no knowledge, interest or concern in the health of the industry, their only interest being what dividends may be had for the shareholders they represent.

26. The policy of permitting corporations to pay the salaries of union officials is manifestly and obviously wrong and should be forbidden.

27. As an additional comment on management, I wish to point out that the Arai Plant of the Dainippon Celluloid Company, one of the best managed plants, the productivity of labor is reported by the management to be four percent above pre-war.

28. While I cannot be sure, I am strongly inclined to believe that allocation is carried to a greater extent than is necessary. On the other hand, a great deal of raw material now allocated in the chemical industry should be free of allocation. This would clean up some unfortunate situations and be a step toward normalcy.

29. The manufacture of dyes in Japan, in general, is well organized. The plants are reasonably good. The management and technical men are better than average. If the dye industry is allowed to proceed as it is going now, it should make an early recovery and produce exportable goods. It would be possible to go at length into this matter but all the industry really needs is an adequate supply of raw material and, I repeat, to be let alone.

30. The plastic industry needs help and encouragement. Competent organizations are contemplating expanding plastic production. The Dainippon Celluloid Company, is an excellent example of what a good plastic factory should be. In general, the industry can and should grow to be an important one, but it will need foreign help. I especially hope the Japanese companies will give serious attention to vinyl plastics.

31. As to the pharmaceutical industry, it should be, and before the war was, good. In some cases it is; in other cases it needs a very strong hand as many of the pharmaceutical products are not up to USA and world standards. I understand one factory is at a standstill, its stock rooms full, unable to sell its products because they do not meet world standards. It might be wise if the Japanese government imposed world standards for pharmaceuticals. This industry should be very profitable and produce goods for export.

32. The paint industry seems to be in perfectly competent hands. The need for paint is very great but the industry is held back for lack of raw materials. As the need is so great, every effort should be made to provide the industry with the necessary materials.

Recommendations

I recommend:

a. That Japanese chemical companies be encouraged to do all that may be done to find the best possible men to fill the top executive and administrative offices. That is the age limit established by some companies stands in the way, encourage the waiving of it until the emergency is rehabilitation is past.

b. That funds be made available—how is not within my knowledge and not in my province to say—to Japanese chemical companies deserving help, at a low rate of interest, not over 4½% and for a reasonably long time.

c. That the moving of chemical plants for reparations be stopped.

d. That all Fischer-Tropsch plants, in such state as they may be, be razed to the ground, metal parts and machinery not properly useful be bundled into scrap and removed from the premises.

e. That limitations of output of potential war products be carefully viewed so that legitimate industries shall not be handicapped by unnecessary restrictions.

f. That the Deconcentration Board be encouraged in a policy of not breaking up organizations except in urgent and very clear cases.

g. That the Executive Engineering Board such as described in paragraph 16 be appointed, it being recognized as a temporary measure.

h. That measures be taken to reduce the demand for sulphur in fertilizer products. This means, among other things, encouraging the manufacture of urea and ammonium nitrate. To that end authorization to produce nitric acid and ammonium nitrate must be given fertilizer manufacturers.

i. That Japanese engineers be permitted to travel abroad to study the chemical industry, even if only in libraries.

j. That Japanese salesmen be permitted to go aboard to promote future Japanese sales.

k. That dollars be made available to the Japanese chemical companies to pay for foreign advice and information.

l. That attention be given to everything combatting Communism, such as permanence of employment in existing plants, improved transportation from home to plants, recreational centers in bleak areas, etc.

m. That the Japanese Government be encouraged to keep more accurate records, filed so that they will be more easily available than they seem to be now.

INDEX TO ADVERTISERS

ATOMIC BOMB AND HAZARDOUS RADIATION

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can be a definite hazard. If an alpha particle emitter reaches the stomach the hazard is dependent, in part, upon the body metabolism for that particular alpha emitter. The emitter may readily be eliminated by the body or it may be absorbed. Some alpha emitters are absorbed and deposited in the bone marrow and kidneys. The short range of the alpha particle which is released in the bone marrow is no safeguard. The intense ionization which it produces along its short path damages the blood forming organs in the marrow. This leads directly to a depression in the white and red blood count and eventually to symptoms characteristic of bone destruction. It is estimated that more than one microgram of plutonium, which is an alpha emitter, is a hazard if it is deposited in the skeletal structure of man.

The beta particle has a mass of only about 1/8000 of that of the alpha particle. Therefore, its range in matter is much greater. Like the alpha particle it also penetrates matter and dissipates its energy by ionization. The radioactive fission products emit beta particles of about 2 Mev average energy. A 2 Mev energy beta particle has a range in air of about 7 meters and a range in body tissue of nearly 1 centimeter. Thus, beta particles are somewhat of an external hazard since they are capable of penetrating and damaging the skin. However, the beta emitter is a greater hazard if it gains entrance to the body and is deposited or fixed in the tissue.

The beta and alpha particle emitters will be present in the form of dusts. Therefore, after a contaminating; i.e. a low level burst, the necessary safety precautions are evident. Personnel who are working in areas contaminated with alpha and beta particle emitters should be masked. They should not eat, drink or smoke in the contaminated area. Personnel with open wounds should avoid such areas. It is apparent that the proper discipline for avoiding the hazard of alpha and beta emitters is much the same as good gas discipline for areas contaminated with persistent chemicals.

The gamma radiation presents quite a different problem. The gamma photons also dissipate their energy in producing ionization. The number of ions produced per centimeter of path is small and, therefore, the paths are long. For gamma photons of interest in this work about an inch of lead is required, as a shield, to reduce the intensity of the gamma radiation by 75 per cent. About 10 inches of concrete are required to produce the same reduction in intensity. Since the gamma radiation which arises during the actual explosion of the bomb is very intense, quite thick shields would be required for the protection of personnel within a radius of several hundred yards of the zero point.

Gamma radiation penetrates body tissue with ease and produces ionization throughout the body. This ionization of molecules of the body tissue leads to the destruction of body cells and tissue damage. It is difficult to visualize any sort of individual protective equipment which would be useful as a shield against gamma radiation.

Most of the body effects are not cumulative, and an individual can tolerate a certain level of exposure to radiation for a considerable period of time which is measured in years. Exposure to gamma radiation is measured in roentgens. This unit will not be defined here.[9] It is generally assumed that an individual will suffer no ill effects if his exposure does not exceed 0.1 roentgen per 24 hour day. This is a low level of exposure. An individual who was in the open and a few hundred yards from zero point for the Hiroshima explosion received an exposure measured in hundreds of roentgens of whole body radiation. An exposure level higher than 0.1 roentgen per day must be set for certain military operations. The 0.1 roentgen per day level is set for individuals constantly exposed over a period of years.

The history of an individual's exposure is expressed in terms of his radiation dose. The dose is the product of the exposure multiplied by the time of exposure. Thus, an individual who is exposed to 0.1 roentgen per day for five days has received a dose of 0.5 roentgens. It appears than an individual can withstand, without ill effects, a dose of several hundred roentgens provided that the exposure is small for any one day. If the daily exposure is increased the total dose must be decreased if the individual is to escape injury.

It appears, therefore, that in an atomic war a soldier may be "radiologically" expended even while he is in the best of health. This means that he has acquired his total safe radiation dose and that he may not be exposed to more radiation if he is to escape radiation injury. He will still be a good fighting man as long as he is not exposed to more radiation. It is obvious that such considerations present many new and novel staff problems.[10]

Nothing has been said to this point concerning the effects of neutron radiation upon the human body. There is no lingering neutron radiation and the neutron problem is one of shielding against the prompt radiation.

The neutron also produces ionization in body tissue. The neutron is a small body with no electric charge. In this respect it differs from the alpha and beta particles which are charged. The neutron has a mass very nearly equal to that of the hydrogen atom.

Alpha and beta particles produce intense ionization along their paths due to the fact that they carry an electric charge. The neutron, due to the fact that it has no charge, does not ionize directly. An energetic neutron may strike a hydrogen atom, in tissue, and give it a high velocity. The impact also tears away the electron of the atom and leaves it an ion. This energetic ion, due to its charge, will produce ionization as does the alpha or beta particle. Thus the energetic neutron produces ionization by an indirect process.

The neutrons which arise in an atomic explosion are energetic but they quickly lose their energy as they penetrate air or solid materials. However, the low energy neutron can penetrate matter by a diffusion process. Neutrons quite readily diffuse through lead and other heavy materials. Such materials are of but little value as neutron shields.[11]. In fact, many light-weight materials are better for slowing down neutrons. The low-energy neutron diffuses readily through body tissue until it is captured by an atom of the tissue. Nitrogen is present in body tissue and the nitrogen atom may capture a neutron as described by the following equation,

$$N^{14} + n^{1} \longrightarrow C^{14} + H^{1}$$

The proton (H^1) is ejected with considerable energy in this reaction and dissipates its energy by ionizing atoms of tissue. The C^{14} is a radioactive form of carbon. It decays by beta particle emission and has a half life of over 1,000 years. It is not much of a hazard due to this long half life. There are, however, other atoms present in body tissue which are capable of capturing neutrons in reactions which yield radioactive isotopes which have short half lives. A typical reaction is described by the following equation,

$$P^{31} + n^{1} \longrightarrow P^{32} + \text{gamma photon}$$

The radioactive P^{32} has a half life of only 14.3 days and decays as follows,

$$P^{32} \longrightarrow S^{32} + \text{beta particle}$$

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CHEMICAL CORPS KEY PERSONNEL

Office, Chief, Chemical Corps, Washington 25, D.C.—Chief, Chemical Corps, Maj. Gen. A. H. Waitt, Cml C; Deputy Chief, Col. E. C. Wallington, Cml C; Executive, Maj. J. O. Quimby, Cml C; Chief, Supply and Procurement Div., Col. H. M. Black, Cml C; Chief, Plans, Training and Intelligence Div., Col. J. C. MacArthur, Cml C; Chief, Research and Engineering Div., Col. W. M. Creasy, Cml C; Chief, Inspection Division, Lt. Col. Thomas H. James, Cml C.

Army Chemical Center, Maryland—Commanding General, Brig. Gen. E. F. Bullene, Cml C; Commanding Officer, Edgewood Arsenal, Col. R. T. Beurket, Cml C; Commandant, CC School, Col. G. Marshall, Cml C; Commanding Officer, Technical Command, Col. J. A. MacLaughlin, Cml C; President, Chemical Corps Board, Col. H. W. Rowan, Cml C.

Western Chemical Center, Tooele, Utah—Commanding Officer, Col. P. F. Powers, Cml C; Executive Officer, Lt. Col. W. S. LeRoy, Cml C.

Pine Bluff Arsenal, Pine Bluff, Arkansas—Commanding Officer, Col. W. A. Copthorne, Cml C; Executive Officer, Maj. L. E. Anderson, Cml C.

Rocky Mountain Arsenal, Denver, Colorado—Commanding Officer, Col. Crawford M. Kellogg, Cml C.

Camp Detrick, Frederick, Maryland—Commanding Officer, Maj. H. J. Isbell, Cml C.

Chicago Chemical Procurement District, 226 W. Jackson Blvd., Chicago, Ill.—Commanding Officer, Maj. F. J. Hurley, Cml C.

Dallas Chemical Procurement District, 1114 Commerce St., Dallas 2, Texas—Commanding Officer, Maj. A. C. Hamilton, Cml C.

Atlanta Chemical Procurement District, 294½ Peachtree Street, Atlanta, Ga. Commanding Officer, Maj. Vincent J. Kosebutski, Cml C.

Boston Chemical Procurement District, Boston Army Base, Boston, Mass. Commanding Officer, Lt. Col. William E. R. Sullivan, Cml C.

New York Chemical Procurement District, 111 E. 16th St., NYC—Commanding Officer, Lt. Col. J. F. Escude, Cml C.

San Francisco Chemical Procurement District, Oakland Army Base, Oakland, Calif.—Commanding Officer, Col. J. M. McMillin, Cml C.

San Jose Project, Office, Chief, Chemical Corps, St. Thomas, Virgin Islands, BWI—Commanding Officer, Col. Paul R. Smith, Cml C.

Chemical Corps Officers with the Army Field Forces

Headquarters, AFF, Fort Monroe, Virginia—Chemical Officer, Col. L. M. Johnson, Cml C.

Headquarters, First Army, Governors Island, New York—Chemical Officer, Col. J. R. Burns, Cml C.

Headquarters, Second Army, Fort George G. Meade, Md.—Chemical Officer, Col. T. H. Murphy, Cml C.

Headquarters, Third Army, Fort McPherson, Ga.—Chemical Officer, Col. R. B. Strader, Cml C.

Headquarters, Fourth Army, Fort Sam Houston, Tex.—Chemical Officer, Lt. Col. R. O. Gordon, Cml C.

Headquarters, Fifth Army, 1660 E. Hyde Park Blvd., Chicago 15, Ill.—Chemical Officer, Col. H. B. Bramlet, Cml C.

Headquarters, Sixth Army, Presidio of San Francisco, Calif.—Chemical Officer, Col. S. E. Whitesides, Cml C.

Chemical Corps Officers Reserve Corps Instructors

First Army Area
Capt. J. N. Klein, Office of Senior State ORC Instructor, 90 Church St., New York City; Lt. Col. F. A. Rohrs, Capt. K. J. Wilson, Office of Senior State ORC Instructor, PO Bldg., 402 E. State St., Trenton, N. J.; Lt. Col. H. D. Tyson, Office of Senior State ORC Instructor, PO Box 646, 726 King St., Wilmington, Del.

Third Army Area
Lt. Col. C. B. Drennon, Jr., 708 Frank Nelson Bldg., Birmingham, Ala.; Capt. L. H. Evans, Jr., 101 Cone Street, Atlanta, Ga.; Maj. E. Escudero, Columbia, S. C.

Fifth Army Area
1st Lt. R. J. Schram, 1660 East Hyde Park Blvd., Chicago 15, Ill.; Capt. S. T. Bonds, 310 Federal Office Bldg., Third Ave., and Washington Ave., S. Minneapolis, Minn.; Maj. C. H. White, 12th and Spruce Sts., St. Louis, Mo.

Sixth Army Area
Lt. Col. A. M. Dunn, Presidio of San Francisco, Calif.; Capt. E. F. Them, Room 1606 Textile Tower, 7th Avenue and Oliveway, Seattle 1, Wn; Capt. T. C. Moore, Fort MacArthur, Calif.

ROTC Instructors
Ohio State University, Columbus 10, Ohio, Maj. J. C. Braxton; Purdue University, Lafayette, Indiana, Lt. Col. L. B. Cottingham; Texas A. & M., College Station, Texas, Maj. A. O. Wiken; Georgia School of Technology, Atlanta, Georgia, Lt. Col. N. I. Decker; MIT, Cambridge, Massachusetts, Lt. Col. J. W. Fitzpatrick and Capt. William Bell.

Foreign Service—Theater Chemical Officers
Headquarters, USA, European Command — Chief Chemical Officer, Col. C. E. Loucks; Headquarters, USA, Far East Command, Chief Chemical Officer, Col. D. R. King; Headquarters, USA, Pacific, Chief Chemical Officer, Lt. Col. R. W. Breaks; Headquarters, USA, Caribbean Command, Chief Chemical Officer, Col. R. A. Johnson; Headquarters, USA, Alaska, Chief Chemical Officer, Maj. G. A. Eaton.

ANNUAL BANQUET

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U.S. Air Force, Col. John F. Babcock addressing the members stated in part: "The business of making war is probably more distasteful to the modern military man than to others, primarily because he has experienced war by direct contact. But this experience has also taught him the lesson of preparedness and its importance. * * * It is with this concept that the Air Force evidences great interest in the field of chemical warfare, because chemical weapons and munitions strengthen the aircraft as a weapon of war to a very great degree.

"We in the field of aircraft armament, which includes chemical weapons and munitions, are particularly anxious to effect the closest relationships with the Chemical Corps.

"Since one of the primary Air Force functions is the delivery of munitions, you can readily see what we must continue to depend upon the Chemical Corps and the chemical industry to supply the Air Force with the necessary chemical warfare material when military operations dictate their use."

* * *

Representing General Jacob L. Devers, Chief, Army Field Forces, Col. Leonard M. Johnson, Chemical Officer for Army Field Forces, stated in part: "As you all know, at the close of the war and as a result of the rather violent demobilization, the Army was very much disorganized. Chemical Corps troops in the Regular Army were reduced at one time to two units, with a total strength of about 270 officers and men. As of 1 May this year, we now have a total of eighteen units with a total authorized strength of slightly over 2,000 officers and men."

Commenting on the necessary cooperation of the armed forces with industry, Colonel Johnson stated that in the future an even closer cooperation is necessary "to insure the continuity of the effort that won the victory for us in World War II." He declared, "It is by the work of such an organization as the Armed Forces Chemical Association that this cooperation and continuity of effort may be fostered and maintained."

* * *

In addition to the aforementioned, the following were honor guests at the Association banquet:

Rear Admiral John A. Snackenberg, Deputy Chief, Bureau of Ordnance, U. S. Navy; Brig. Gen. Edward Montgomery, Chief, Supply Group, Logistics Division, U. S. Army; Brig. Gen. E. F. Bullene, Commanding General, Army Chemical Center; Col. Charles E. Loucks, Chemical Officer, European Command and President of the AFCA's European Chapter; Mr. Neil Gavron, representing the Technical Officers Association of the United Kingdom; Maj. Gen. Sidney P. Spalding, Col. Norman D. Gillett and Mr. Harry E. Blythe of the Munitions Board; Mr. James H. Boak, Operations and Training Division, U. S. Army; Col. M. T. Hankins, representing the Joint Chiefs of Staff; Brig. Gen. Edwin A. Zundel, Commanding General, Camp Holabird, Md.

ATOMIC BOMB

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The beta particle is ejected with 1.7 Mev energy.

The biologic effects of neutrons are not as well understood as are those of gamma photons. Also, the permissible exposure and dose are not known with precision. It is known that neutron radiation is a greater hazard than is gamma radiation of the same intensity. It appears that neutron radiation is about five times as damaging, biologically, as is gamma or beta radiation of equal intensity. The tolerance dose for neutron radiation is, therefore, correspondingly less. Much work remains to be done in studying the neutron hazard.

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